3.0 PRICING

Why Neustar

- Nearly HIGHLY CONFIDENTIAL in immediate savings to Service Providers in year-one of the new contract term
- Fixed pricing model that completely eliminates cost uncertainty
- HIGHLY CONFIDENTIAL reduction in effective rate per transaction over the new contract term
- Zero marginal cost for usage, encouraging innovation and incremental value
- Up to HIGHLY CONFIDENTIAL in additional value associated with NPAC/SMS innovations
- Avoids at least $719 million in transition costs to Service Providers and disruption to millions of consumers

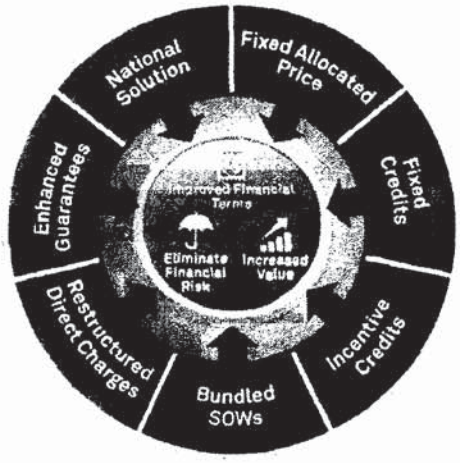
Neustar is pleased to present pricing terms in response to the 2015 LNPA RFP. Our proposal will enable us to continue to provide the fastest, highest-quality, most complex LNP service in the world for the benefit of U.S. consumers, enterprise customers, and the U.S. Telecommunications Industry ("Industry"). Our mission is to make LNP work more seamlessly, effectively, and efficiently. Neustar offers unquestioned neutrality while delivering an integral element of critical telecommunications infrastructure enabling the Industry to focus on innovation and strategy rather than attempting to recreate a well-running LNPA service and system.

Neustar's pricing solution provides significant near and long-term benefits to the Industry, combining cost certainty, savings, and increased value while virtually eliminating financial risk.

The primary benefits include:

- Better Financial Terms—across-the-board cost improvement
- **Incremental Value**—reducing Industry infrastructure costs, maximizing business performance and efficiency
- Risk Avoidance—eliminates all financial risk

These benefits are realized and optimized through a holistic pricing approach consisting of a fixed structure integrated with credits, Bundled SOWs, enhanced financial guarantees, and a national solution (Full Combined Proposal) that removes risk and ensures certainty. The combination of these features creates a powerful solution. The components of our solution include:



- Industry **Fixed Rate** eliminates cost uncertainty
- **Fixed Credits** provide guaranteed savings
- **Incentive Credits** provide additional savings if value-based milestones are achieved
- **Bundled SOWs** drive value by developing all Industry-driven innovations at no additional charge
- **Restructured Direct Charges** reduce and/or eliminate costs and enable the Industry to realize the full value of the NPAC/SMS
- **Enhanced Guarantees** demonstrate commitment to satisfying increased performance standards
- **National Solution** eliminates the significant expense and increased Industry exposure of the transition of one or more regions to another supplier

Neustar's approach maximizes Industry benefits and unlocks incremental NPAC value. Our proposal makes significant commitments regarding reliability, security, service delivery, usability, customer service, business analytics, and price while virtually eliminating operational and financial risks. Neustar's Proposal should be evaluated comprehensively across all these value-driving parameters.

Immediate Realization of Improved Financial Terms for the Industry

Neustar's optimized pricing solution provides significantly improved financial terms to the Industry. Our solution offers near- and long-term savings and price stability, while encouraging our customers to realize the NPAC/SMS' full value. As designed, the Industry can expect the following financial benefits over the term of the contract:

- Elimination of the annual price escalator
- Nearly [HIGHLY CONFIDENTIAL] year-one savings (vs. current contract run rate) via credits and other effective price discounts
- No transaction limits or incremental transaction costs
- Industry-requested SOWs at no additional charge
- Significant reduction and restructuring of Direct Charges
- Elimination of Industry exposure to bad debt

Increased and Continuous Value Creation

Neustar's Proposal brings value to the Industry from every possible angle. We are proposing to reduce prices and remove real and potential cost burdens that prevent Users from fully utilizing the NPAC/SMS. Neustar is stepping up our financial support for the rapid development of the NPAC/SMS' value, via several distinct and unique value-creation programs. As a result of these programs, and other actions, the Industry will gain the following benefits:

- Between [HIGHLY CONFIDENTIAL] reduction in the effective rate per transaction over the new contract term
- Incentive Credits when certain innovation-oriented milestones are achieved
- Industry SOWs development worth over [HIGHLY CONFIDENTIAL] included in fixed price
- No incremental charges for future innovation and usage via fixed rate and Bundled SOWs
- Identified innovation opportunities provide approximately [HIGHLY CONFIDENTIAL] of total value to the Industry
- Services that are currently billed as Direct Charges will be free of charge via the new NPAC Portal
- Most efficient global LNP system with no sacrifice in quality of service

Virtual Elimination of Transition and Performance Risk

Selection of Neustar avoids the high levels of risk and potential financial costs associated with transition of the NPAC/SMS to a new LNPA. Transition risk includes not only the significant cost and risk of LNPA system transition, but also the opportunity risks and costs associated with the reallocation of resources from true strategic efforts and priorities. In addition, the Industry may well be forced to respond to a major breakdown in NPAC/SMS functionality, leading to the need for crisis management and the potential loss of consumer confidence.

Neustar has proactively increased the extent to which we mitigate or eliminate every potential category of performance risk by increasing performance penalties and guarantees. The following highlights of our solution ensure continued outstanding performance:

- A commitment to deliver higher levels of performance with proposed increases to potential performance penalties
- Substantial increases in performance bonds which provide additional levels of security
- A national solution which eliminates the potential for significant ecosystem redundancy and inefficiency
- Avoidance of at least $719 million in transition cost in the first contract year: a conservative estimate based on an assumption of a reasonably clean transition (see Proposal Section 3.6.1)
- If extrapolated over multiple years the total transition cost impact would exceed $1 billion
- Industry resources and investment that would have been consumed by an expensive transition can be deployed on strategic priorities

Comprehensive Pricing Solution to Deliver Total Value

Neustar's pricing solution is comprehensive and structured so the Industry will benefit not only from improved costs but from the value provided to the Industry at no additional charge. A summary description of our pricing solution and how each element creates value for the Industry is set forth in Table 3-1.

Table 3-1 Neustar's Pricing Solution

Solution	Description	Value to Service Providers
Industry Fixed Rate	• Firm, fixed baseline price for length of the new contract term • No inflationary adjustments until June 2020 • No transaction limits or incremental transaction costs	✓ 100% cost certainty ✓ Significant reduction in effective rate per transaction ✓ Zero cost for increased NPAC/SMS usage ✓ Neustar absorbs all performance and business risk (economic environment, inflation, transaction volume)
Fixed Credit	• Fixed credits applied in initial years of the new contract term • Reduces Industry Fixed Rate	✓ Provides immediate savings in initial year ✓ [redacted] in savings over the first four years of the new contract term
Incentive Credits	• Credits applied when specifically identified functionality or database milestones are achieved • Three ways to achieve credits: increased TNs in database, adding functionality, increased database field population • Reduces Industry Fixed Rate	✓ Provides up to [redacted] in additional contract savings ✓ Milestones align with increased utility to the Industry ✓ The Industry can virtually lock-in future credits by exceeding in-year thresholds.
Bundled SOWs	• Industry-approved SOWs at no additional charge • Available to drive innovation programs and other Industry requirements • Eliminates all charges for existing SOWs	✓ Up to [redacted] in SOW development value delivered at no additional charge ✓ Industry is able to drive innovation and utilization at virtually no incremental cost ✓ Suggested innovations are estimated to drive [redacted] in additional Industry value
Restructured Direct Charges	• Rationalizes existing service portfolio and adds new options and features • Categories of services include Access Charges, Technical Support, Testing and Interface Turn-up, Customer Support, and Training • Services available via new NPAC Portal	✓ Significant price reductions ✓ Simplified pricing structure ✓ Free options available via NPAC Portal ✓ Encourages interaction with NPAC/SMS ✓ New services provide additional, flexible, cost-effective options
Enhanced Guarantees	• Performance penalties increased along with SLR performance requirements • Secured firm commitment for [redacted] in performance bonds • Elimination of Revenue Recovery Collections • Additional ISO and TL certifications	✓ Provides additional financial security and guaranteed performance ✓ SLRs performance credits doubled, GEP price reductions increased significantly ✓ Performance bond protection represents almost two months of allocable charges (increased 9x)
National Solution	• Neustar seamlessly continues as the nation's single authoritative LNPA, in all Regions	✓ Avoids significant transition cost and associated opportunity costs ✓ Avoids inefficiencies associated with coordinating and operating multiple NPAC/SMS systems

Nearly HIGHLY CONFIDENTIAL **in Year-one Savings from Credits and Discounts**

As illustrated in Exhibit 3-1 Neustar's proposed pricing model yields material near-term savings. The calculation of year-one savings (vs. current contract exit run rate or $496 million) is summarized as follows:

- The Industry Fixed Rate represents a reduction to the current contract exit run rate (approximately HIGHLY CONFIDENTIAL in year-one savings)
- Credits (fixed and incentive) further reduce the Industry Fixed Rate (up to an additional HIGHLY CONFIDENTIAL in year-one savings)
- Other effective discounts accrue from reductions to Direct Charges, elimination of the Revenue Recovery Collections, and Bundled SOWs (representing another HIGHLY CONFIDENTIAL in year-one savings)

The net result is up to HIGHLY CONFIDENTIAL **in year-one savings or effective industry charges of** HIGHLY CONFIDENTIAL **in 2016** (represented as "Year-one effective savings" in Exhibit 3-1).

HIGHLY CONFIDENTIAL

Not only does the pricing model represent substantial near-term savings, it offers long-term savings and price stability. The credits and effective discounts amount to HIGHLY CONFIDENTIAL in total savings over the new contract term. These savings ensure the effective industry rate remains below the current contract exit run rate for the entire new contract term.

Over HIGHLY CONFIDENTIAL in Incremental Value

Table 3-2 catalogues over HIGHLY CONFIDENTIAL in value created above and beyond the Industry Fixed Rate. In addition to the near- and long-term savings previously described, Neustar's Proposal offers new value from systemic technology innovations and improvements, and mitigation of financial and performance risk.

A full accounting of the ecosystem value that Neustar will provide via improvements in financial terms, technical specifications, and platform innovations is set forth in Table 3-2.

Table 3-2 New Value Creation (in millions)

NPAC/SMS Value Features	Proposal References	7-Year Value
Credits (a)	Section 3.1, 3.2	
Other Effective Discounts (b)	Section 3.3, 3.4, 3.5.3	
Total Credits and Effective Discounts		
New Contract Value (c)	Section 1.1, 1.2, 1.4, 3.5.1, 3.5.2	
NPAC/SMS Innovations (d)	Section 1.2, 1.5	
Additional Value		
Total Credits/Savings and Value		

a) Fixed and incentive credits

b) Reductions to Direct Charges, elimination of existing SOWs and Revenue Recovery Collections (RRC), and Bundled SOWs

c) Includes value of new performance requirements (e.g., service availability), customer service enhancements, (e.g., 24x7x365 help desk), and value of increased performance bonds

d) Estimated Service Provider benefits from innovation programs (increased revenue and cost efficiencies)

Pricing Structure Eliminates the Innovation Cap

Our proposal's allocated pricing structure, without transaction limits, removes all remaining cost uncertainty, and allows the Industry to focus on strategic priorities and consumer experience. In so doing, customers may utilize the NPAC/SMS without regard to the possibility of unexpected incremental costs caused by increased NPAC/SMS usage, or by the types of transactions processed.

Transactions are projected to grow between 8.0% and 12.3% per year. The lower end of this range represents an extension of historic growth rates. The upper end represents adoption of additional IP services (Machine-to-Machine ("M2M"), Device Registry, IP interconnect, etc.). **The effective rate per transaction to the Industry would be reduced by HIGHLY CONFIDENTIAL to between HIGHLY CONFIDENTIAL per transaction by the end of the new contract term.**

Neustar's effective rate per transaction is shown in Exhibit 3-2.

HIGHLY CONFIDENTIAL

Already the Most Efficient Global LNP System

Neustar operates the most efficient and cost-effective LNP system in the world. The U.S. provides the shortest average wireless porting duration. This is accomplished on the most complex, sophisticated, and vast LNP network. In addition to being the most efficient, the U.S. NPAC/SMS is the most cost-effective when the effective price of a number port is measured against average revenue per user (ARPU) in each country.

Using data obtained from regulatory agencies and Telecommunications Management Group, Inc. Consulting Group, (TMG), Neustar has compiled a histogram showing average time to complete a wireless number port for each country where data was available. The U.S. ranks first out of 58 countries.

In addition, Neustar compiled a histogram showing the ratio of average wholesale porting cost expressed in terms of days of wireless ARPU. For example, if the wholesale LNP cost for a given country is $5 and ARPU averages $30 per month then MNP Cost would be expressed as five ARPU days ($5 per number port/ $30 Monthly ARPU x 30 days per month = 5 ARPU Days). This provides a measurement of LNP cost-effectiveness. The U.S. ranks first out of 50 countries.

A summary of international mobile number portability data is provided in Exhibit 3-3.

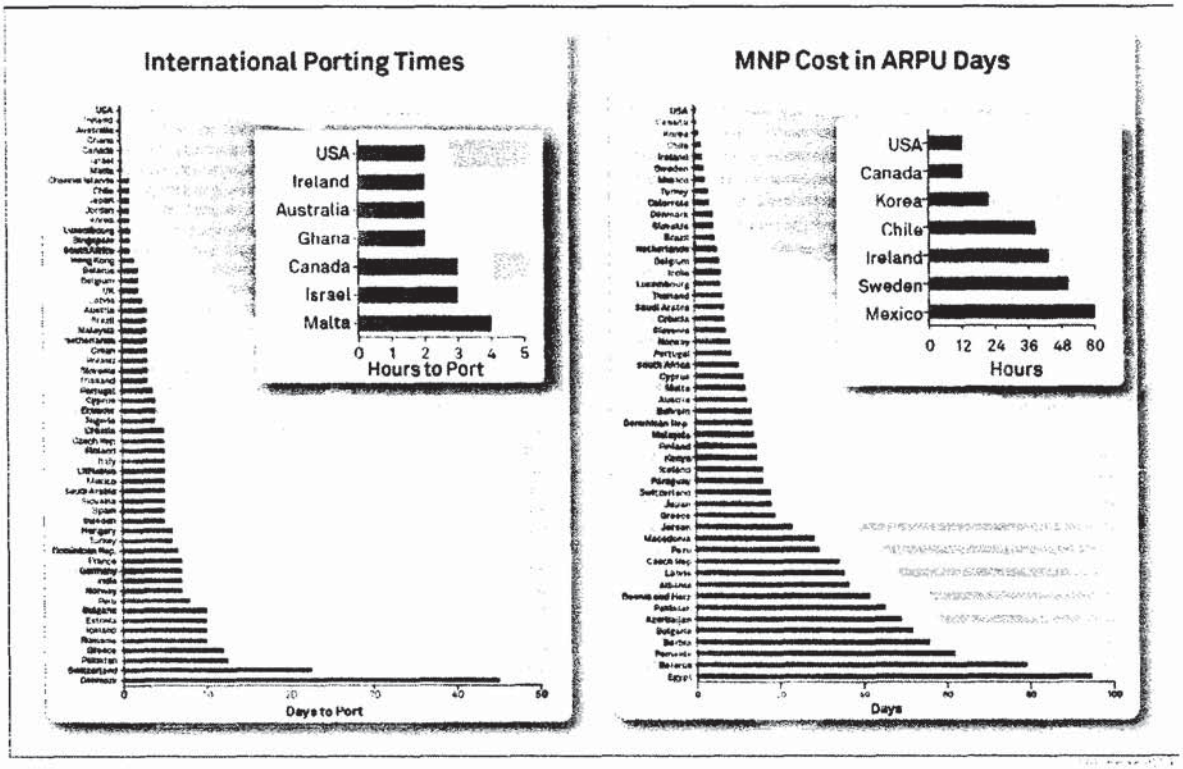


Exhibit 3-3 Port Completion Times and MNP Cost in ARPU Days (based on recent data)

Not only is the U.S. NPAC/SMS by far the fastest and most reliable, it is already the most cost-effective. Neustar is proposing herein to distinguish the U.S. NPAC/SMS even further.

Strategic Pricing to Ensure Performance Excellence and Drive Innovation

Proposal Section 1.5 outlines robust opportunities for increasing the value of the NPAC/SMS for Service Providers; providing a potential innovation roadmap for the NPAC/SMS that addresses the transformational changes already impacting the Industry. These include the evolution of numbering to accommodate IP and VoLTE Network transition, de-coupling TNs from LATA and rate area boundaries, NPAC/SMS support for M2M services, Individual Telephone Number Pooling, Identity Management (via digital certificates assigned to TNs), Fixed Line SMS interoperability, a stolen handset registry, and robust Business Analytics, among others. Each of these innovations will directly support future revenue streams or provide increased efficiency for our customers. Neustar has completed a study of the benefits these NPAC/SMS innovations would provide to Service Providers, estimating approximately [HIGHLY CONFIDENTIAL] in added value would be realized by our customers over the new contract term.

Described below are several distinct ways in which Neustar's pricing model supports these innovations:

- **Financial commitment to "Always On" and "Always Accurate" operating environments** is inherent in Neustar's pricing solution. The increases in performance standards requested in the 2015 LNPA RFP (e.g., 99.99% Service Availability, a tenfold increase) reflect the expectations of Industry's end users for near perfect performance. For example, Identity Management and M2M services require an "Always On" environment. Neustar's full support for such improvements is demonstrated by our willingness to increase the penalties associated with violations of the Industry's upgraded standards.

- **Support for changing market conditions and the need for rapid response** is provided by our package of Bundled SOWs (Proposal Section 3.3) for strategic NPAC/SMS software development. Bundled SOWs are the mechanism for creating value through innovation. Additionally, this SOW approach provides a flexible and valuable means for rapid service deployment as needs arise (for example, to address OSS/BSS support for M2M devices).

- **Expanded support for Customer Service, Service Delivery, and Business Analytics** reflects the same concerns Service Providers have for directly addressing individual 24x7x365 customer needs and the need for customer insight. Neustar's NPAC Help Desk support will be expanded to become a full service 24x7x365 operation. In addition, Neustar will provide—at no additional cost—the NPAC Portal, and licensed access to Neustar's proprietary ElementOne analytics platform. The NPAC Portal will consolidate current interfaces, provide improved customer support, and access to critical information. ElementOne is a state-of-the-art business analytics engine.

- **Increased NPAC/SMS functionality** including the use of new fields to carry URIs, device information, and more will support the industry's strategic priorities. For example, placing all Service Provider TNs in the NPAC/SMS with IP-network URIs will be critical for supporting national interconnect and M2M while advanced analytics can assist service providers in making essential business decisions related to subscriber movement and network usage. Neustar will provide up to [redacted] in Incentive Credits that will be earned as the Industry achieves targets related to innovations.

- **Elimination of virtually all incremental cost for utilization of the NPAC/SMS** is accomplished through a combination of a fixed rate, fixed credits, and removal of all transaction limits: Fixed rate, combined with the opportunity to complete an unlimited number of transactions eliminates any possibility of unexpected incremental costs at any transaction level. This is especially important if new fields are added. For example, implementation of one or more M2M fields will allow the Industry to develop a means of using the NPAC/SMS to catalogue and track M2M devices.

- **Reductions in Direct Charges** address increasing customer requirements. As use cases expand it will be important to ensure the platform is available to more Service Provider users. Reduced Direct Charges address this need via lower access charges for mechanized interfaces, and the virtual elimination of charges for log-on IDs.

In summary, Neustar's price proposal has been structured to ensure the NPAC/SMS continues to innovate and generate exceptional Industry value during an era of exceptionally rapid change. Innovation is a core element of Neustar's Proposal—a set of technical, management, and pricing features that are integrated throughout our offer.

3.1 Allocable Charges

Neustar's proposal for Allocable Charges includes an Industry Fixed Rate for 2016 to 2022 that represents a reduction to the current contract exit run rate. HIGHLY CONFIDENTIAL

The allocated Industry Fixed Rate provides 100% cost certainty and virtually unlimited opportunity to use the NPAC/SMS for additional utility. This structure has been optimized to include anticipated economies of scale and efficiencies. The Industry Fixed Rate will also include several additional cost reductions and/or exclusions including elimination of billing and collection fees and bad-debt reserves, Bundled SOWs, and all other existing SOWs (Proposal Sections 3.3 and 3.5.3).

Annual allocable charges are to be billed monthly and spread evenly throughout the year.

Neustar's proposal for Allocable Charges compared to the current contract exit run rate is set forth in Table 3-3.

Table 3-3 Pricing Summary (in millions)

Years (a)	Current Contract Exit Run Rate	2016	2017	2018	2019	2020	2021	2022
Industry Fixed Rate (b)	$496.1	HIGHLY CONFIDENTIAL						
Fixed Credit (c)	-							
Maximum Incentive Credit (d)	-							
Net Industry Charges (e)	$496.1	HIGHLY CONFIDENTIAL						

a) 12-month periods commencing with new contract term. the anniversary of which ends each year on June 30
b) Reduction to the current contract exit run rate then 5% per annum inflationary adjustment in 2021 and 2022
c) Provides fixed credits for immediate front-loaded savings in initial years of the contract
d) Reductions tied to achievement of Incentive Credits (Proposal Section 3.2)
e) Industry Fixed Rate minus Fixed Credit minus maximum Incentive Credits

3.2 Incentive Credits

The value of the NPAC/SMS is a function of the types of applications available and the extent to which the database is populated with Industry data. Since inception of the NPAC/SMS, the Industry has benefited as capabilities have expanded and the database has become more robust.

Neustar supports continued database enrichment by proposing "Incentive Credits" of up to [redacted] over the new contract term. These credits reduce the Industry Fixed Rate when specific defined milestones are reached.

Incentive Credits will be applied for milestone achievement in three categories: 1) Number of active SVs in the NPAC database, 2) NPAC functionality additions, and 3) Field population in the NPAC database.

Neustar's proposal for Incentive Credits is set forth in Table 3-4.

Table 3-4 Maximum Incentive Credits (in millions)

Years (a)	2016	2017	2018	2019	2020	2021	2022	Total
SV Credit	[redacted]							
Functionality Credit	[redacted]							
Field Population Credit	[redacted]							
Total Incentive Credits (b)	[redacted]							

a) 12-month periods commencing with new contract term, the anniversary of which ends each year on June 30

b) Equal to the sum of the maximum SV Credit, maximum Functionality Credit, and maximum Field Population Credit

3.2.1 Incentive Credit Detail

The details for the three key categories of Incentive Credits are as follows:

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Table 3-5 SV Credit Examples (SVs and Credits in millions)

Years (a)	2016	2017	2018	2019, etc.
Lower SV Threshold	HIGHLY CONFIDENTIAL			
Upper SV Threshold	HIGHLY CONFIDENTIAL			
Active SVs				
Pro-Rated SV Achievement (b)				
Pro Rated SV Credit Ratio (c)				
Credit Available				
Applied Credit				

a) 12-month periods commencing with new contract term, the anniversary of which ends each year on June 30

b) (Active SVs minus Lower SV Threshold) divided by (Upper SV Threshold minus Lower SV Threshold)

c) If Pro-Rated SV Achievement is greater than , then plus Pro-Rated SV Achievement times (maximum of 100%)

2. Functionality Credit—HIGHLY CONFIDENTIAL

Table 3-6 Functionality Credit Examples (in millions)

Years (a)	Credit Available	2016	2017	2018	2019, etc.
Functionality Milestone 1					
Functionality Milestone 2					
Functionality Milestone 3					
Functionality Milestone 4					
Credit Earned (b)					
Cumulative Credit Earned (c)					
Previous Applied Credit (d)					
Applied Credit (e)					
Cumulative Credit Applied					

a) 12-month periods commencing with new contract term, the anniversary of which ends each year on June 30
b) [redacted] per Functionality Milestone achieved (assumes that new functionality remains operable and/or active)
c) Total credit earned to date
d) Total credit applied prior to current year
e) (c) minus (d) but not more than [redacted] in any given year

3. Field Population Credit—HIGHLY CONFIDENTIAL

Mechanics for the Field Population Credit are illustrated in Table 3-7.

Table 3-7 Field Population Credit Examples (SVs, Fields, and Credits in Millions)

Years (a)	2016	2017	2018	2019, etc.
Lower SV Target				
Upper SV Target				
Target Optional Fields per SV				
Lower Optional Field Target Threshold (represents 50% earned credit) (b)				
Upper Optional Field Target Threshold (represents 100% earned credit) (b)				
Active SVs				
Actual Optional Fields per SV				
Actual Optional Fields				
Pro-Rated Optional Field Achievement (c)				
Pro Rated Optional Field Credit Ratio (d)				
Credit Available				
Applied Credit				

a) 12-month periods commencing with new contract term, the anniversary of which ends each year on June 30

b) Lower and Upper Optional Field Target Thresholds = HIGHLY CONFIDENTIAL

c) Pro-Rated Optional Field Achievement = HIGHLY CONFIDENTIAL

d) HIGHLY CONFIDENTIAL

3.3 Bundled SOWs

Neustar agrees to the Industry's requirement in RFP Section 13.4 that the cost for any Statements of Work requested by the NAPM LLC shall be included as part of the Industry Fixed Rate. In addition, upon the start of the new contract term, there will be no further recurring charges for existing SOWs and there will be no charges for SOWs to implement functionality resulting from the 2015 LNPA RFP. Beyond these RFP requirements, many additional elements of Neustar's proposal, such as the NPAC Portal, are also included in the Industry Fixed Rate. An annual allowance ("SOW Allowance") for any other functionality, including functionality that becomes required as the result of regulatory action, also is provided. The SOWs covered by the SOW Allowance are referred to as "Bundled SOWs."

Allocable charges for current SOWs are included in the Industry Fixed Rate and will not result in a drawdown or deduction against any SOW Allowance for any year. Elimination of charges for current SOWs will result in Industry savings of [HIGHLY CONFIDENTIAL] per year. An example is SOW 11 (LNPA Billing and Collection Operations and System Expansion), which currently results in approximately [HIGHLY CONFIDENTIAL] per year in allocable charges.

The annual SOW Allowance is provided for each contract year against which additional services can be performed. The combined value of these SOW Allowances equals [HIGHLY CONFIDENTIAL] over the new contract term. The SOW Allowance will be [HIGHLY CONFIDENTIAL] in the first year of the new term of the contract and will increase in [HIGHLY CONFIDENTIAL] increments each year, reaching [HIGHLY CONFIDENTIAL] in the final year of the contract. These annual amounts are substantially more than historical spending for SOWs and should be more than adequate to cover additional SOWs required for new functionality and innovation. Bundled SOWs will be developed under the business practices currently utilized by Neustar and the NAPM LLC. The SOW Allowance amount will be applied against the value of future SOWs.

ElementOne is another innovation that will be provided at no additional charge and without drawing down any SOW Allowance. Access to the ElementOne platform via licenses for authorized NPAC/SMS Users will not result in any additional charge, nor will it be deducted against any SOW Allowance for any given year. The remaining innovations described in Proposal Section 1.5 as well as other new functionality will follow the Bundled SOW process. It is our estimate that all other NPAC/SMS innovations described in Proposal Section 1.5 can be developed well within the total provided SOW Allowance.

Bundled SOWs are a vital component of Neustar's commitment to evolve and drive innovation. Bundled SOWs, along with the Industry Fixed Rate provide pricing certainty while the absence of transaction limits and the availability of incentive credits create a pricing environment that drives innovation. The SOW Allowance for each year of the new contract term is set forth in Table 3-8.

Table 3-8 Annually Applied SOW Allowances (in millions)

Years (a)	2016	2017	2018	2019	2020	2021	2022	Total
Annual SOW Allowance	[HIGHLY CONFIDENTIAL]							

a) 12-month periods commencing with new contract term, the anniversary of which ends each year on June 30

3.4 Direct Charges

Direct Charges are those charges for NPAC/SMS services requested by Users and provided by the LNPA that do not constitute "*Services*" under the Master Agreements, such that they are billed directly to, and paid directly by, the requesting User.

Neustar has evaluated each category of Direct Charges and identified how pricing and provisioning can be improved so the Industry can better leverage the capabilities of the NPAC/SMS platform.

Neustar proposes to replace the existing Direct Charges service portfolio with one that is flexible, customer-oriented, encourages greater interaction with the NPAC/SMS, and allows Users to obtain free services on a state-of-the-art NPAC Portal.

As each Direct Charge category is reviewed, it is noted which services will be available, free of charge, and with no usage limits, via the NPAC Portal.

Direct Charges are an important pricing element that should be evaluated accordingly. These services are critical for all carriers because they enable utilization of the NPAC/SMS. Neustar's proposal provides a thoughtful and thorough approach to Direct Charges.

3.4.1 Access Charges

Access Charges include fees related to the various methods used to access the NPAC/SMS (DS0, DS1, VPN, and Ethernet (new)) and fees for log-on IDs. Highlights include:

- DS1 and VPN charges are reduced by
- Two capacities of Ethernet access ports have been added; a) up to 10MB, and b) 11MB to 100MB
- The 11MB to 100MB Ethernet option will include one free bulk data download (BDD) per Region per day
- Log-on ID price will be reduced from per ID to a free package of log-on IDs for a customer's authorized users

Neustar's proposed rate card for Access Charges is set forth in Table 3-9.

Table 3-9 Access Charges

Charges	Description	Unit	Price	Billing Frequency
Mechanized access charges: DS-1	Dedicated port to NPAC network	Per dedicated line port (DS-1)		
Mechanized access charges: DS-0	Dedicated port to NPAC network	Per dedicated line port (DS-0)		
Mechanized access charges: Ethernet	Ethernet port (up to 10MB) to NPAC network	Per Ethernet private line port		
Mechanized access charges: Ethernet	Ethernet port (11MB to 100MB) to NPAC network; includes one free BDD per Region per day	Per Ethernet private line port		
NPAC Portal/ Low Tech Interface Access Charges	VPN port to NPAC network	Per VPN port		
Log-on ID	Cost of assigning and delivering a log-on ID	Per log-on ID		

3.4.2 Dedicated Technical Support

Dedicated Technical Support is provided upon User's request. This category does not include Testing and Interface Turn-up Charges, which are discussed in Proposal Section 3.4.3. Highlights of the charges include:

- The NPAC Portal will provide Users the opportunity to develop and execute ad hoc reports free of charge with no usage limits. The NPAC Portal will include access to our ElementOne Analytics Platform (EAP); providing Users a robust, scalable and secure analytics platform that provides rich data and cutting-edge analytics.
- Users may still request ad hoc report assistance from Neustar and will be billed an hourly rate for initial development and a per-report rate thereafter for execution.

Neustar's proposal for Technical Support Charges is set forth in Table 3-10.

Table 3-10 Dedicated Technical Support Charges

Charges	Description	Unit	Price	Billing Frequency
NPAC Portal: Ad hoc Reports	Ad hoc reports developed or executed by the User via the NPAC Portal	---	No charge	--
Dedicated Technical Support	Hours of dedicated support by a qualified engineer	Per hour		
Initial ad hoc report development	Dedicated support to develop and produce an initial ad hoc report	Per hour		
Subsequent ad hoc report (NSR assisted)	Dedicated support to execute an existing report	Per report		

Notes:

- Porting errors, code mismatches (SOW 66). and inadvertent ports (SOW 19) are now categorized as "Billable NPAC User Support Manual Requests" (Category: Customer Support)

3.4.3 Testing and Interface Turn-up

Testing and Interface Development Charges consist of Direct Charges for Neustar-assisted testing assistance of any type, as well as charges for creating a new mechanized interface. Highlights Include:

- Neustar's approach to testing services utilizes a "service family" approach that applies the same standard rate to all types of systems testing
- A standard rate of [redacted] per day per assigned employee will be charged for all testing and interface turn-up services

This approach allows the User to determine where testing resources will be most effective without regard to differing costs.

Neustar's proposal for Testing and Interface Turn-up Charges is set forth in Table 3-11.

Table 3-11 Testing and Interface Turn-up Charges

Charges	Description	Unit	Price	Billing Frequency
Testing and Interface Turn-up Charges	See notes below	Per Day	[redacted]	[redacted]

Notes:

- Testing services include vendor and Service Provider Turn-up Testing, new functionality testing, Interoperability Testing, Regression Testing, Initial LSMS Interoperability Testing, Initial SOA Interoperability Testing, Mechanized Interface Testing per Association, Direct Access Testing, and Daily Testing (formerly "Hourly Testing")
- Interface Turn-up Charges refers to any support besides testing that is required to complete the turn-up of a Mechanized Interface

3.4.4 Customer Support

Customer Support Charges consist of a variety of activities performed by Neustar to assist customers in day-to-day operations. Highlights Include:

- Each month, the Neustar Help Desk will complete up to [redacted] Billable User Support Manual Requests for no charge per customer
- With the expansion of help desk support to a 24x7x365 operation, premium support charges for help desk calls initiated outside normal business hours will be eliminated
- Neustar is adding a small charge for bulk data downloads (BDDs); however, Users electing an 11MB to 100MB Ethernet port will be allowed to complete one BDD per Region per day at no charge
- Users may run standard reports, change their GUI password, re-enter their GUI password, and re-enter GUI log-on ID free of charge if these activities are performed on the User Portal.

Neustar's proposal for Customer Support Charges is set forth in Table 3-12.

Table 3-12 Customer Support Charges

Charges	Description	Unit	Price	Billing Frequency
NPAC Portal: standard reports	Any standard reports executed via the NPAC Portal	---	No charge	---
Change GUI Password via the NPAC Portal	Use of NPAC Portal to change GUI Password	---	No charge	---
Re-enter GUI Password via the NPAC Portal	Use of NPAC Portal to re-enter GUI Password	---	No charge	---
Change GUI log-on ID via the NPAC Portal	Use of NPAC Portal to change GUI log-on ID	---	No charge	---
Standard Report: Neustar Assisted	User-requested generation of a standard report by Neustar Help Desk personnel	Per standard report		As incurred
Billable User Support Manual Requests	First 5 customer support requests each month will be provided free of charge	Per request	First Free per month, then each	Monthly
BDD—requested by NPAC customer utilizing an Ethernet 11MB to 100MB port	Automated or manual request of BDDs by customer using a 11MB to 100MB Ethernet port	Per Region per BDD	No charge for BDD per Region per day. See below for additional BDD requests	---
BDD—requested via NPAC Portal	Automated requests of BDDs via NPAC Portal.	Per Region per BDD request		As incurred
BDD—requested via Neustar Help Desk	Neustar Help Desk assisted delivery of BDDs	Per Region per BDD request		As incurred

Notes:

- Activities identified as "Billable NPAC User Support Manual Requests" are listed following Table 3-20
- For billing purposes, porting errors, code mismatches (SOW 66), and inadvertent ports (SOW 19) have been added to User Support Manual Requests
- The premium charge of per hour for contact initiated outside of normal business hours is eliminated

3.4.5 Training

Neustar will increase and enhance the amount of training material and resources available to customers via the NPAC Portal. Highlights Include:

- An NPAC/SMS knowledge base that includes comprehensive online training modules, troubleshooting information, process and procedure manuals, and white papers
- All knowledge base materials, including NPAC/SMS training modules, will be accessible to authorized Users free of charge
- Training modules will cover all common NPAC/SMS functions
- On-location training (either at Neustar's training location or at the customer's premises) will be available using a simplified "service family" approach that applies the same standard rate of [redacted] per session (plus expenses) for all types of on-location training
- The [redacted] fee covers up to [redacted] attendees per training session

Neustar's proposal for Training Charges is set forth in Table 3-13.

Table 3-13 Training Charges

Charges	Description	Unit	Price	Billing Frequency
Training via the NPAC Portal	Training and other materials obtained via the NPAC Portal will be entirely free of charge with no limits	---	No charge	---
In-person training (per training session)	Single rate per session for up to 10 attendees (generally 1.5 days)	Per Session	[redacted]	As incurred

3.5 Enhanced Guarantees

Neustar proposes to substantially increase the Industry's financial guarantees and protections. These guarantees involve three areas that are described below in greater detail. First, Proposal Section 3.5.1 describes Neustar's commitment to increase the dollar and percentage amounts of performance credits related to Service Level Requirements (SLR) and the Gateway Evaluation Process (GEP) referenced in RFP Sections 9 and 4.1, respectively. These proposed penalty increases are consistent with the increased technical and operational performance commitments of the quoted RFP sections. Second, Proposal Section 3.5.2 describes a [redacted] increase in the amounts of the performance bonds we will offer to the Industry in response to VQS Question 3.6.3. Third, Neustar agrees to eliminate Revenue Recovery Collections, protecting the Industry from bad debt associated with allocable charges (RFP Sections 13.4 and 14.2). Fourth, as described in Proposal Section 1.4, Neustar will implement and/or upgrade several new performance and security audits that further ensure the Industry is protected from the growing threat of IT security breaches.

3.5.1 Performance Credits and GEP Price Reductions

The Master Agreement's SLRs and GEP provide financial assurance to the Industry that the LNPA will perform in accordance with stringent requirements for NPAC/SMS service and interface availability. Metrics and credits/reductions are set at levels that demand outstanding performance. Because operational execution is the primary consideration in assessing LNPA performance, the Industry associated severe penalties to missing one or more metrics.

Neustar proposes to more than [redacted] our exposure for SLR Performance Credits and increasing GEP Price Reductions by approximately [redacted]. Under this Proposal, Neustar's exposure will exceed [redacted] per month for failure to meet SLR and GEP requirements.

Neustar's proposed changes to SLR Performance Credits and GEP Penalties are summarized and illustrated in Exhibit 3-4.

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The increased requirements of the 2015 LNPA RFP are significant: e.g., several requirements (including Service and Interface Availability) require a tenfold increase in performance (i.e., 99.99%) from the requirements set forth in the current Master Agreement. A key change in the GEP for Elements 1a, 1b, 2, and 3 is the elimination of the "3 strikes rule". These GEPs currently generate penalties only if Neustar misses the required metrics three times in a given year (or two months in a row). Under the terms of the RFP, this flexibility has been eliminated and all GEP misses will result in a penalty. The RFP's stringent requirements, which include 99.99% Service Availability, combined with removal of "3 strikes", and high penalty rates, sends a clear message that LNPA service performance is of utmost importance to the Industry. Neustar supports this direction and is confident we will continue to provide exceptional performance.

Neustar is confident in our ability to exceed the Industry's performance expectations, steadily improving operational performance to the point where our reliability is never in doubt. Over the last 32 quarters the Industry and Neustar have effectively managed risk out of the LNP process.

Neustar's proposal for new SLR Performance Credits is set forth in Table 3-14.

Table 3-14 SLR Performance Credits: Current vs. Proposed

		Per Region	
RFP SLR	**SLR Title**	**Current Monthly Penalty**	**Proposed Monthly Penalty**
SLR 1	Service Availability	$14,000	$25,000
SLR 2	Scheduled Service Unavailability	$5,000	$10,000
SLR 3	Partial Service Unavailability	-	$10,000
SLR 4	LSMS Broadcast Time	$5,000	$10,000
SLR 5	SOA to NPAC Interface Rates	$5,000	$10,000
SLR 6	LSMS to NPAC Interface Transaction Rates	$5,000	$10,000
SLR 7	SOA/ LSMS Interface Availability	$14,000	$25,000
SLR 8	Unscheduled Backup Cutover Time	$5,000	$10,000
SLR 9	NPAC/ SMS Partial Disaster Restoral Interval	$5,000	$10,000
SLR 10	NPAC/ SMS Full Disaster Restoral Interval	$5,000	$10,000
	Maximum Monthly SLR Penalties	**$63,000**	**$130,000**

Neustar's proposal for new GEP Price Reductions is set forth in Table 3-15.

Table 3-15 GEP Price Reductions: Current vs. Proposed

Percentage of monthly net allocated Industry charges		*Per Region*	
RFP GEP	GEP Title	Current Monthly Penalty	Proposed Monthly Penalty
GEP 1a	Service Availability Failure		
GEP 1b	Partial Service Unavailability		
GEP 1c	Interface Availability Failure		
GEP 2	Report Satisfaction		
GEP 3	Scheduled Service Unavailability		
GEP 4	Benchmarking Satisfaction		
GEP 5	Root Cause Analysis & Reporting		
GEP 6	Problem Escalation		
GEP 7a	Billing Timeliness of Delivery		
GEP 7b	Billing Accuracy		
	Maximum Monthly GEP Penalties		

3.5.2 Performance Bonds

In the unlikely event Neustar is unable to serve as the LNPA, performance bonds provide protection to the Industry. Payments under the bond will serve as partial compensation for losses sustained by the Industry in such a case.

Throughout the term of the current contract, Neustar has maintained one performance bond per region in the amount of (total of for all U.S. regions). NPAC/SMS activity has increased by several orders of magnitude since the performance bonds were originally executed. In 2012, amounts under performance bonds equaled less than one week of allocated NPAC/SMS charges. Given our commitment to lowering Industry risk via guaranteed performance, Neustar proposes to increase significantly the amounts available under its performance bonds for the new term of the Master Agreement from per region) to per region). The new amount equates to approximately days of allocated charges. We have a commitment in place from HIGHLY CONFIDENTIAL The Commitment Letter is attached in Tab "Performance Bond Commitment Letter".

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3.5.3 Collections Certainty

Neustar will eliminate Revenue Recovery Collections ("RRC"). RRC is the mechanism that currently allows the LNPA to charge the Industry for estimated bad debt expense, via a reserve. By removing the RRC Neustar will create additional cost certainty for the Industry by eliminating bad debt exposure associated with Allocable Charges, and comply with RFP Sections 13.4 and 14.2, subject to specific mechanics and limits to be defined in the Master Agreement.

Neustar will also reduce allocable charges by the amount of collected charges from Users not subject to allocable charges. This provision complies with RFP Sections 13.4 and 14.2 and is also subject to the specific mechanics and limits to be defined in the Master Agreement.

3.5.4 Mitigation of Performance and Information Risk

Neustar recognizes the importance of providing the Industry with state-of-the-art security management and quality of service audits. Many performance and security audit measures have long been in place, and Neustar has performed exceptionally well. However, in the interest of further enhancing our performance and leaving no stone unturned in the interest of protecting our Service and our customers from impairments that can lead to serious breaches, Neustar proposes to implement and/or upgrade the following additional compliance audits: TL9000 (upgrade to ISO 9001), ISO/IEC 27001, and ISO 22301. A complete discussion of Neustar's current and future plans in regard to these certifications can be found in Proposal Section 1.4.

3.6 National Solution

Transition costs should always be a significant element when considering the selection of a new vendor. In the case of LNP, transition costs should be a primary consideration because LNPA transition would present an unprecedented and exceptionally complex system migration affecting each and every Service Provider. Conservatively, the transition costs associated with LNP transition are estimated at $719 million in the first year alone.

A regional LNPA solution creates even more complexity. All costs associated with a national transition apply, plus additional inefficiencies from a multi-vendor environment. Additional costs include end-to-end testing for two LNPAs, and ongoing connectivity and administration costs. Neustar estimates that the cost of implementing a second LNPA for a single region is over greater than the proportional cost of a national transition.

The Industry is undergoing significant technology and service evolution. Technology changes, consumer service portfolios, and the need for wireless networks to efficiently transport IP calls and data (e.g. Voice over LTE) are strategic priorities for the Industry. The LNPA service is a critical element of this change, and services developed and operated by Neustar today will be needed to support countless customer turn-ups, technology migrations, network consolidations, and policy executions over the next ten years

Given Neustar's outstanding track record, the risk of transition is an unnecessary and untimely undertaking, particularly for a first-time complex migration affecting a wide-reaching and myriad set of interconnected systems. Transition issues and failures will necessarily distract Service Providers from their primary objective – evolving and competing in a marketplace that is experiencing tremendous change. Selecting Neustar avoids any risk of transition and ensures Industry resources can be focused on strategic priorities.

Proposal Section 1.6 addresses transition risks and costs in detail.

Following are two discussions of transition issues and costs:

- Proposal Section 3.6.1 addresses national transition costs in the event of a transition to a new nationwide LNPA
- Proposal Section 3.6.2 details the only reasonable approach to LNP administration in the U.S. is a Full Combined Propsal.

3.6.1 National Transition Costs

Navigant Economics, an economics and consulting firm, has completed a comprehensive analysis of the costs associated with LNP transition in a report entitled, "Estimating the Costs Associated with a Change in Local Number Portability Administration". The report estimated a national LNPA transition would result in approximately $719 million in quantifiable year-one transition costs as a result of increased LNPA error rates and the significant level of required testing by Service Providers. If extrapolated over multiple years the total impact would exceed $1 billion. This report can be found in the Proposal Attachments section of our Proposal (RFP Section 15.1, "*Optional Attachments*" in the IASTA Tool).

The primary reason for such a high transition cost is the sheer scope of the transition itself.

- At the time of Navigant's study, the NPAC/SMS contained approximately 5.2 billion populated data fields for 560 million SV records (the database has since grown by 10%). Each populated field refers to an aspect of an individual end user's communications service. Any data that is not copied or interpreted correctly by the new LNPA is likely to lead to an end user service failure, and result in a customer service call, engineering research, and possible revenue loss. Database transition would be the first transition impact felt by customers.

- Errors in transaction processing will generate the highest transition impact over an extended period of time. Neustar currently processes over 500 million transactions a year. For every completed transaction there are over 20 CMIP messages passed between various components of the LNPA and Service Provider systems (i.e., 12 billion CMIP messages per year). Neustar's 15 years of LNPA experience plays a significant role in the success of LNP in the U.S.. Many of the NPAC/SMS' transactions consist of modifications of thousands or even millions of records related to a single project (to change a specific field). Neustar's expertise ensures the activity for these projects is properly allocated over several days or weeks and that each transaction is verified end-to-end. In addition, the Industry relies on Neustar to understand exactly how to structure such projects and to know what can and can't be done in the available transaction windows. This requires experience and knowledge that Neustar brings to the table.

- Outages would likely increase both in number and in duration. While the overall impact of these is expected to be less important than the other elements, such incidents would be highly visible, impacting consumer confidence.

- End-to-End testing charges would be significant, involving not only every SOA and LSMS, but every downstream system that relies on NPAC/SMS data.

Navigant's analysis only assessed the potential impacts associated with operational errors, increased system outages, and testing that can be expected from any LNPA transition. The report finds that approximately $719 million in cost would result from 7.1 million end users experiencing a direct impact of an error in year-one, generating 4.8 million incremental complex Service Provider escalations.

Highlights of transition impacts that are detailed in Navigant's paper are found in Table 3-16 and Table 3-17.

Table 3-16 Year-One Costs Resulting from LNPA Transition (in millions)

Year One Costs	Service Credits	Customer Service	Engineering	Total
System Transition	$14.9	$65.4	$102.5	$182.8
Transaction Processing	$49.2	$211.6	$189.6	$450.5
Outages	$0.3	$13.6	$0.7	$14.6
Testing	$0.0	$0.0	$71.0	$71.0
Total	**$64.5**	**$290.6**	**$363.8**	**$719.0**

Table 3-17 Year-One Customer Impacts Resulting from LNPA Transition (in millions unless otherwise noted)

Error Types	Errors Broadcast to End Users	Errors Impacting End Users	End User Complaints	End User Churn (in thousands)
System Transition	2.7	1.5	1.1	19
Transaction Processing	6.7	5.4	3.5	140
Outages	-	0.3	0.2	50
Total Customers Impacted	**9.4**	**7.1**	**4.8**	**209**

Potentially eclipsing direct transition costs are the opportunity costs caused by the need to refocus time and money, from strategic innovation and market competition, to crisis management and reestablishing consumer confidence. In summary, selection of Neustar will ensure continued operational performance and zero LNPA transition cost during a critically important era of transformational change in the telecommunications industry.

3.6.2 Full Combined Proposal (Regional Cost Avoidance)

The 2015 LNPA RFP permits respondents to submit proposals for one or more regions individually (each referred to as a "Regional Proposal"), for one or more combinations of regions together, either for fewer than all regions (each referred to as a "Partial Combined Proposal") or for all seven regions (referred to as a "Full Combined Proposal"). Neustar understands the RFP Bid Process Overview listed in RFP Question 14.1 and is proposing only a Full Combined Proposal. Regional and Partial Combined Proposals create unnecessary operational and cost burdens for Service Providers and risks to consumers and should not be considered by the FoNPAC or the FCC.

U.S. LNP Administration is akin to other Industry-wide services, such as NANPA, National PA, USF Billing and Collection, and the operation of Top Level Domain (tLDs) like .COM, .US, .INFO, .BIZ,—all of which have just one vendor performing the function on behalf of a diverse group of constituents. While businesses sometimes engage multiple suppliers for purchasing commodity products, this not a common practice with complex, service-intensive platforms like the NPAC/SMS. The more deeply interconnected the service, the greater the ripple effect from non-uniform behavior, performance, and change management.

U.S. consumers have come to enjoy the benefits of the most efficient porting experience in the world, regardless of where they live. Service providers, for their part, have the benefit of a national standard for new customer acquisition (particularly for major product launches), national pooling, and network management. By selecting more than one LNPA vendor, particularly any vendor that lacks experience, the FoNPAC would introduce the risk that not all U.S. consumers would enjoy the same ease and expedience of porting on a timely and universally-consistent basis as they enjoy today. Such differences in LNPA service quality could impact some Service Providers' ability to compete on an equal footing and lead to increased complaints to regulatory bodies. The impacts of operating in a multi-vendor environment of the NPAC/SMS include, but are not limited to, the following:

- Increased Service Provider effort and cost to connect their SOAs and LSMSs to multiple live LNPA NPAC/SMS platforms and test beds and maintain those multiple connections
- New software release and new Service Provider feature deployment would likely have to be deferred during transition period
- Failover testing likely would have to be deferred during the transition period
- Increased Service Provider cost and risk in receiving services from two different LNPA vendors, including:
  - Help desk services
  - Reporting services
  - New user services
  - Tunable parameter maintenance
  - Service Provider ID migration limitations and process coordination
  - Resolution of differences among LNPA software implementations, some of which could be service-affecting
  - Data and information from multiple LNPAs into one LNPA Working Group website coordination
  - Neutral change management administration
  - Bulk Data Download (BDD) management
  - Unnecessary development of Service Provider internal processes to accommodate differences in multiple LNPA methods & procedures
  - Unnecessary initial change and ongoing support for the LNP Enhanced Analytic Platform (LEAP) accessed by law enforcement and Intermodal Ported TN Identification Service accessed by telemarketers
  - Negotiation, execution, and reconciliation of differences in Master Agreements with multiple LNPAs
  - Ongoing management and oversight of multiple LNPAs by the NANC, NAPM LLC and FCC

During the last 15 years, the Industry has enjoyed the operational and cost benefits of having a single, nationwide LNPA. Given Neustar's proven track record of superior customer service as the current LNPA, an outcome of having multiple LNPA vendors for the new contract term would represent a major step backwards for the Industry and consumers. Service Providers in some or all regions would be subjected to an extraordinarily risky and costly transition. Given the preponderance of Service Providers that operate in more than one region, the costs and risks of transition will be national in scope, even if only one region is identified for transition. In fact, Regional and Partial Combined Proposals will make transition more costly, because Service Providers affected by a transition will have to manage two vendors during the activity.

If multiple LNPA vendors are engaged, all future changes to the NPAC/SMS will be encumbered. For example, two or more LNPA vendors will have to fully understand the requirements pertaining to the future changes and implement these changes simultaneously, and in exactly the same way from an Industry interface perspective; otherwise operational problems will ensue. In order not to give any LNPA vendor an advantage, it is likely that the Industry will have to procure, select, and pay for a separate vendor to perform the change management function at the NANC LNPA Working Group. The charges for this function will have to be allocated, billed and collected.

Given that in a multi-LNPA vendor environment all NPAC/SMSs are likely to have to carry the same functionality, debates over design and implementation schedules will play a larger role and the Industry will be forced to adhere to the limits of the least capable vendor. If one of the LNPA vendors fails to deliver on schedule, Service Providers and consumers in the affected regions will suffer and not receive the benefits in a timely manner—most likely, the Industry will simply be forced to wait until all LNPA vendors are ready to deploy a given change. These types of issues can be particularly problematic if the FCC has mandated the change to LNP by a deadline. If an LNPA appears to be unable to meet a particular deadline, then Service Providers may have to seek regulatory relief from deadlines and, possibly, relief from fines. This was the case in the NPAC/SMS Regions originally assigned to Perot Systems.

By accepting Neustar's Full Combined Proposal, the Industry will receive continued, superior-rated customer service for the vital LNPA function, evenly-applied to the entire nation through the new contract term. By selecting Neustar, the Industry can avoid all of the substantial negatives—operational complexities and increased costs—associated with Regional and Partial Combined Proposals and multiple LNPAs. And, by selecting Neustar, the Industry will receive the benefit from Neustar's planned upgrades and proposed innovation without any transition risk and without subjecting Service Providers and consumers to numerous potential negative and expensive consequences.

3.7 Additional Qualifications

This Proposal is subject to the qualifications set forth below and elsewhere in this Proposal:

1. The implementation of this Proposal is subject to the parties entering into a definitive agreement for the new term of the contracts.

2. A seven year term to run from the conclusion of the current Master Agreements through the date that equals seven years thereafter (currently July 1, 2015 through June 30, 2022).

3. Payment terms will comply with RFP Section 13.3, which are expected to be consistent with the payment terms and conditions set forth in the existing contracts.

4. Continued effectiveness of the provisions set forth in Section 22.2 and Section 22.3 of the current contract, as introduced by Amendment 70, concerning the assignment of monies due and the granting of security interests.

5. Neustar utilizes a shared operations group that spans the company to support our global infrastructure, corporate-wide product portfolio, and services platform. This infrastructure has been designed to provide services that are reliable, scalable, neutral, and secure. To maximize efficiencies, NPAC/SMS operations are fully integrated into Neustar's overall operations support infrastructure, including general and administrative support functions. Neustar's accounting for costs under this methodology is fully compliant with Generally Accepted Accounting Principles. Therefore, costs and expenses associated with the NPAC/SMS cannot be separately identified or audited in conjunction with VQS Question 3.6.12.

6. The pricing set forth in Neustar's Proposal is a valid quote in accordance with RFP Section 1.7, the terms and conditions of which are subject to being finalized in a definitive agreement between Neustar and the NAPM LLC. If the FoNPAC, NAPM LLC or FCC publicly-announce a recommendation for the selection of another Respondent for any U.S. region or the schedule deviates materially from the dates outlined in RFP Sections 1.5 and 16.1, then Neustar reserves the right to amend its Proposal.

7. All prices are in U.S. Dollars.

8. All prices exclude applicable taxes.

3.8 RFP Pricing Compliance Tables

The following correspond to the Compliance Tables from RFP Section 14.2 and 14.3. These tables are provided for illustrative purposes only and presented to comply with RFP submission requirements. These tables were derived from the terms outlined in Proposal Section 3.

Compliance Tables for Allocable Charges and Direct Charges are set forth in Table 3-18 and Table 3-19 respectively:

Table 3-18 Allocable Charges Pricing Compliance Table (in millions)

	Year 2015-2016	Year 2016-2017	Year 2017-2018	Year 2018-2019	Year 2019-2020	Year 2020-2021	Year 2021-2022
Allocable Industry Flat Fee in U.S. Dollars for All Combined NPAC Regions (a)							
Allocable Industry Flat Fee in U.S. Dollars for MidAtlantic NPAC Region	NA	NA	NA	NA	NA	NA	NA
Allocable Industry Flat Fee in U.S. Dollars for MidWest NPAC Region	NA	NA	NA	NA	NA	NA	NA
Allocable Industry Flat Fee in U.S. Dollars for NorthEast NPAC Region	NA	NA	NA	NA	NA	NA	NA
Allocable Industry Flat Fee in U.S. Dollars for SouthEast NPAC Region	NA	NA	NA	NA	NA	NA	NA
Allocable Industry Flat Fee in U.S. Dollars for SouthWest Region	NA	NA	NA	NA	NA	NA	NA
Allocable Industry Flat Fee in U.S. Dollars for West Coast NPAC Region	NA	NA	NA	NA	NA	NA	NA
Allocable Industry Flat Fee in U.S. Dollars for Western NPAC Region	NA	NA	NA	NA	NA	NA	NA
Optional Regional Combination (must identify Regions)	NA	NA	NA	NA	NA	NA	NA

a) *Represents Net Industry Charges reflected in Proposal Section 3.1, Table 3-3 which assumes the Industry earns maximum Incentive Credits*

Table 3-19 Direct Charges Pricing Compliance Table (in dollars)

	Year 2015-2016	Year 2016-2017	Year 2017-2018	Year 2018-2019	Year 2019-2020	Year 2020-2021	Year 2021-2022
1. Any recurring cost per Virtual Private Network (VPN) access to NPAC network (annual)	HIGHLY CONFIDENTIAL						
2. Any recurring cost per Dedicated Mechanized Interface to NPAC network (annual) (a)							
3. Cost per NPAC User manual request support (b)							
4. Cost per standard report requested by User (c)							
5. Cost per ad hoc report requested by User (d)							
6. Any non-recurring cost per log-on ID established (e)							
7. Any non-recurring cost per mechanized interface established (f)							
8. Cost to support new carrier initial LSMS interoperability testing (one time) (f)							
9. Cost to support new carrier initial SOA interoperability testing (one time) (f)							
10. Per hour cost for LNPA test engineer support subsequent to initial system testing (g)							

a) *Assumes Dedicated Mechanized Interface to NPAC refers to Dedicated DS-0. See Proposal section 3.4.1 for other Mechanized Interface options*

b) *Neustar will provide 5 free completed User Support Manual Request transactions per month. Each additional User Support Manual Request will be charged at per completed request*

c) *No charge for standard reports that are accessed via the NPAC Portal. Standard reports that are provided with assistance from Neustar will be billed at per executed report*

d) *No charge for ad hoc reports that are accessed via the NPAC Portal. Ad hoc reports that are provided with assistance from Neustar will be billed at per executed report plus per hour of dedicated support utilized to produce an initial ad hoc report*

e) *Neustar will provide 10 free log-on IDs per customer. Each additional log-on ID will be charged at Represents daily rate for all testing categories and turn-up of a mechanized interface*

f) *Represents daily rate for all testing categories. See Proposal Section 3.4.3*

g) *Represents daily rate for testing divided by 8, however all testing will be charged at per day. See Proposal Section 3.4.3*

3.9 Billable User Support Manual Request Table

Neustar's complete list of proposed Billable User Support Manual Requests, applied to the applicable section of the Customer Support rate card (Table 3-12) is set forth in Table 3-20.

Table 3-20 Billable User Support Manual Request Table

Category	Description of Request
Create SV	New SP asks Help Desk to issue a new SP Create for a TN (or a range of TNs)
Create SV	Old SP asks Help Desk to issue an old SP Create for a TN (or a range of TNs)
Add Conflict to Pending SV	Old SP asks Help Desk to change the Concurrence flag to "false" on a Pending SV (or SVs, for a range of TNs)
Activate SV	New SP asks Help Desk to issue an Activate for a Pending SV (or SVs, for a range of TNs)
Remove Conflict from Pending SV	Old SP—or New SP, if after SV's Due Date, t2 timer's expiration, and except for case of conflict cause code 50 or 51—asks Help Desk to change the concurrence flag to "true" on a pending SV (or SVs, for a range of TNs)
Modify Pending SV	New SP asks Help Desk to issue a Modify for a Pending SV (or SVs, for a range of TNs)
Disconnect TN	Current SP asks Help Desk to issue a Disconnect for an SV (or SVs, for a range of TNs)
Cancel Pending SV	Old SP or New SP asks Help Desk to issue a Cancel for a Pending SV (or SVs, for a range of TNs)
Look Up SV	SP asks Help Desk to look up an Active SV for a TN (or SVs for range of TNs)
Modify Active SV	Current SP asks Help Desk to issue Modify for an Active SV (or SVs, for a range of TNs)
Audit SV	SP asks Help Desk to issue Audit Request for a TN, or range of TNs, with Active SV(s)
Look Up Network Data	SP asks Help Desk to look up NPA-NXX, NPA-NXX ID, NPA-NXX-X, NPA-NXX-X ID, LRN, or LRN ID to determine associated SPID and/or ID
Change Network Data	SP asks Help Desk to add or to delete NPA-NXXs or LRNs. The SP making a delete request must be the SP that created the data. For an NPA-NXX code create request, the SP must be the code assignee. (There is no charge when the delete request is for a code (but not for an LRN) that is open in the wrong NPAC service area.)
Change GUI Password	SP asks Help Desk to change its GUI Password
Re-enter GUI Logon	SP asks Help Desk to re-enter its GUI Logon which SP has allowed to expire
Porting Errors (SOW 19)	SP asks Help Desk for help to correct port-in-error and failure-to-port conditions
Code Mismatches (SOW 66)	SP asks Help Desk for help to correct NPA-NXX codes opened in network data under SPID that is not associated with the code's current OCN assignee

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March 20, 2013

North American Portability Management LLC
c/o Dan. A Sciullo Attorney at Law
Berenbaum Weinshienk PC
370 17th Street, Suite 4800
Denver, CO 80202

Re: 2015 LNPA RFP

This letter is to advise you that Neustar is a valued surety client of HIGHLY CONFIDENTIAL . Neustar remains in good standing and is qualified for surety capacity sufficient to support the 2015 Local Number Portability Administrator Master Agreement. The seven proposed performance bonds totaling HIGHLY CONFIDENTIAL would ensure Neustar's prompt and faithful performance under the Master Agreements and User Agreements specifications as required by North American Portability Management LLC.

It is our opinion that Neustar is capable of performing the above captioned project as evidenced by its 16 year track record performing as the Local Number Portability Administrator in the United States, experience on similar projects, and its reputation as one of the country's leading solution providers in the communications industry. Based on our current analysis and due diligence performed, HIGHLY CONFIDENTIAL is confident Neustar is qualified to perform the captioned project but as always, HIGHLY CONFIDENTIAL reserves the right to perform normal underwriting at the time of any final bond requests, including without limitation, prior review and approval of relevant contract documents, bond forms, and the financial condition of our client.

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Estimating the Costs Associated with a Change in Local Number Portability Adminstration

By

Hal J. Singer‡

A transition in local-number-portability administrator would likely impose significant costs on U.S. providers of voice services. According to the cost model developed here, providers would incur approximately $719 million in additional cost in the first year of such a transition. These transition costs would take the form of service credits, hands-on customer service, operations research, and additional system testing. In addition to these costs, greater service delays and errors in porting would likely cause some customers to abandon their switch to a new provider, resulting in additional lost revenue (and increased cost per sale) for the providers that are gaining the most market share from their competitors.

‡ Managing Director and Principal at Navigant Economics. Financial support for this paper was provided by Neustar. The views reflects those of the author only, and do not represent the views of Navigant Economics or its parent company. The author would like to thank Gerry Keith, who developed the cost model, Anna Koyfman, who provided general research, and Kevin Caves, who assisted with the econometric modeling.

I. INTRODUCTION

In August 2012, the Federal Communications Commission (FCC) issued a request for proposal that could lead to a change in the identity of local number portability (LNP) administrator.[1] Any transition involving the handoff from one vendor (or system) to another could encounter difficulties. By way of analogy, FairPoint's transition of its information systems from Verizon (the New England territories) created significant problems that, according to the Maine Public Utility Commission, contributed to FairPoint's subsequent bankruptcy.[2] Similarly, United Airlines encountered severe difficulties in the transition of its reservations systems from the former Continental Airlines in March 2012; despite adding 700 employees, the transition caused United's systems to be overwhelmed, and even resulted in tickets being "lost" in the new system.[3] A full seven months after transition, the system experienced its worst failure to date, a worldwide shutdown that led to cancellations and delays affecting tens of thousands of people.

Such examples show that providers of voice services in the United States ("carriers") would likely incur significant additional costs associated with the transition to a new LNP administrator. The extent of the transition-related errors and their associated costs can be modeled based on, among other things, actual database and transactions volumes, estimates of error rates, the time required to correct the errors, and wage rates.

Working with Gerry Keith,[4] I developed a model to estimate the costs to carriers associated with the transition of LNP services to another vendor. In particular, the regime change assessed here contemplates replacing the current administrator for all LNP transactions, including ports among wireless and wireline carriers. These costs would likely manifest themselves in the form of system transition, transaction processing, system outages, and testing. I conservatively assume that these transition costs are completely mitigated within one year. The model is based on transactional data provided by Neustar to estimate the transition costs.

Carriers typically issue service credits to complaining customers, and they incur customer service expenses and operations research costs when problems are escalated to managers. The extent of the transition-related errors and their associated costs are estimated based on similar experiences in the communications industry. A significant number of batch-update transactions occur because many of the fields in the portability database identify various types of add-on services and third-party providers such as caller ID vendors, which are subject to error. I estimate that Carriers would incur incremental costs of $719 million in the first year of the transition.

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1. FCC Public Notice, Wireline Competitive Bureau Seeks Comment on Procurement Documents for the Local Number Portability (LNP) Administration, DA 12-1333A, released August 12, 2012.

2. *See* FairPoint's SEC Form 10-Q/A for the first quarter, 2009, at 3; Maine Public Utility Commission Examiner's Report, June 3, 2010, Docket No. 2010-76, Docket No. 2010-77, and Docket No. 2010-78.

3. Christopher Elliott, *A chaotic computer switch in United-Continental merger*, CHICAGO TRIBUNE, May 1, 2012, *available at* http://www.chicagotribune.com/travel/sns-201205010000--tms--traveltrctntt-b20120501may01,0,2851270.story.

4. Gerry Keith was the former director of business research at Illinois Bell and has over 30 years of experience in the telephone industry.

II. The Cost Model

There would likely be four sources of errors encountered by carriers during the first year of transition to a new vendor: (1) systems transition (errors introduced during transition when NPAC records are propagated to the carriers); (2) transaction processing (error rates above current baseline due to lack of experience or expertise handling transactions that require customer coordination); (3) unplanned outages (increased probability of LNP service outages that would introduce long LNP porting delays) and (4) testing (testing costs between the new vendor and the carriers plus internal OSS/BSS testing). To simulate the magnitude of these errors, I used industry benchmarks from LNP regimes in transition, as well as Neustar's experience over the past decade with administrating the LNP system in the United States. The magnitude of each error category depended on the end-user experiences. For example, technical errors for features such as caller ID generate smaller costs than errors with call placement.

Each type of error described above could generate three types of incremental costs for carriers: (a) service credits (when customers demand refunds for service delays), (b) hands-on customer service (when customers place service calls), and (c) engineering costs (researching the errors and system testing). Similar to the approach in modeling errors, our approach to modeling error costs relied on industry benchmark figures, as well as Neustar's experience associated with administrating the LNP regime. Table 1 summarizes the most important assumptions relating to these errors.

Table 1: Critical Model Assumptions and Support

Assumption	*Support*
Percentage of Error associated with a simple field	These error rates are similar to those indicated by Alcatel and Lucent in their study.
Number of active fields in database	Actual count of populated fields in the NPAC database
Number of LNP transactions	Actual count of transactions
Complex error rates	Based on a factor applied to Neustar's goals for these types of transactions
Hours to fix errors	Carrier expertise
Employee pay rate	Carrier expertise
Time and cost of carrier testing	Carrier expertise
Additional Outage Times	Neustar's early experience

A. Errors Associated with Database Transition and Operation

A new LNP administrator would likely operate based on the transition of the existing database and LNP system from Neustar. Conversion problems typically arise with transitioning such a database and systems from one vendor's system to another. These problems include the misinterpretation of database fields and database structure by software or personnel. The complexity of various uses of the database and transactions can be shown by the long list in the FCC's RFP of different specifications that the LNP regime

must meet.[5] An example of such errors is the conversion of a public-telephone switched network to an IP network. Alcatel/Lucent found that 1.5 percent of the customers in an ILEC database would generate an error when converting from the public-switched telephone network to an IP network.[6] The basic error rate of one-quarter of a percent per populated field was used to model the NPACs transition to an alternate vendor. This percentage was applied against the number of telephone number records in the NPAC database.

The new LNP administrator would have to operate its system and carrier interfaces with new personnel. These personnel and programs would be relatively inexperienced with new porting requests from carriers—especially those requests involving complex changes associated with mass updates to the database (for example, to change a third-party caller ID vendor). The error rates of a new LNP administrator were partially based on Neustar's performance benchmarks for these types of transactions, while the simpler, market-generated porting transaction error rate was assumed to equal one quarter of one percent per populated field.

B. Estimating the Costs of the Errors, Outage Impacts, and Carrier Testing

The cost of each error was computed for the credit that a carrier may have to provide to the end user, the customer service time, and operations time to research and correct the error. Several factors were used to determine the impact of an error on carrier costs. For example, one factor indicates the percentage of errors that create a direct customer impact for each field, from 100 percent for porting to 0 percent for information-only fields. Other factors determined whether an error would involve a customer credit, the use of customer service time, or operations time to research and correct the error. Other factors estimated the amount of time involved and the associated cost. The model estimates only the impact for the first year of operation and conservatively assumes a declining error rate for transactions during the first year.

Historically, Neustar had higher system outage rates during its early years than in it's most recent years. When the system is down, porting is delayed, which impacts customers and carriers. The impact of this delay is computed by the number of porting transactions affected and the length of the delay using similar factors to the impact of errors, with greater relative impact as outage time increases. The carriers have a number of interfaces with the system to send and receive porting changes.

The carriers would have to test their interfaces with the new vendor to ensure that their systems interface properly as well as test all internal OSS/BSS systems that utilize NPAC data. These costs were estimated based on carrier expertise in such testing.

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5. 2015 LNPA Technical Requirements Document, FCC DA 12-3333A3, released Aug. 26, 2012.
6. Alcatel-Lucent, Solving the NGN Data Migration Challenge (2007), at 2.

C. Results

The results of the model are shown in Table 2.

TABLE 2: MODEL RESULTS (COSTS IN MILLIONS)

Year One Costs ($Millions)	Service Credits	Customer Service	Engineering	Total Year 1 Transition Cost	Percent of Total Cost
Systems Transition	$14.9	$65.4	$102.5	$182.8	25.4%
Transaction Processing	$49.2	$211.6	$189.6	$450.5	62.7%
Outages/ System Unavailability	$0.3	$13.6	$0.7	$14.6	2.0%
Testing	$0.0	$0.0	$71.0	$71.0	9.9%
Total Year One Costs	**$64.5**	**$290.6**	**$363.8**	**$719.0**	**100.0%**
Percent of Total Cost	9.0%	40.4%	50.6%	100.0%	

Only a portion of these costs would be incurred by wireless carriers. Table 3 shows the decomposition of costs by carrier type.

TABLE 3: DECOMPOSITION OF COSTS BY CARRIER TYPE (COSTS IN MILLIONS)

Year One Costs ($Millions)	Service Credits	Customer Service	Engineering	Total Year 1 Transition Cost	Percent of Total Cost
Wireless Costs	$14.1	$97.1	$119.3	$230.6	32.1%
Wireline Costs	$50.4	$193.5	$244.5	$488.4	67.9%
Total	$64.5	$290.6	$363.8	$719.0	100.0%

Table 4 summarizes the impact on customers resulting from the transition.

TABLE 4: CUSTOMER IMPACT SUMMARY (END USERS IN THOUSANDS)

Error Types	Errors Broadcast to End Users	Errors Impacting End Users	End User Complaints	End User Churn (includes abandonment)	% Impacted End User Churn (includes abandonment)	Lifetime Revenue Impact ($M)
Systems Transition	2,737	1,456	1,090	19	1.3%	$38.1
Transaction Processing	6,695	5,350	3,527	140	2.6%	$326.0
Unplanned Outages	-	332	226	50	15.2%	$149.5
Total End Users	9,432	7,138	4,843	209	2.9%	$513.6

According to the model, 7.1 million end users would be impacted by a potential transition—21 percent of whom could not receive phone calls, 72 percent of whom would experience problems with service features, and seven percent of whom could not port their numbers. Additionally, there would be 4.9 million complaints in the form of customer service calls to service providers, and there would be 209,000 end users who would leave their service provider. The lifetime revenue impact to the carriers that lose the opportunity to win these customers would exceed $500 million which is incremental to the $719 million described previously.

D. Sensitivity Testing

I performed several sensitivity analyses by testing the importance of some of the major assumptions underlying the cost model. For example, assuming there were no errors introduced in the transition of the database to another vendor, the impact would be about $200 million less; assuming that any improvement in the handling of the transactions would be offset by errors that were made in the second or later years, the impact would be about $200 million more. To err on the side of conservatism, our model assumed a new vendor would rapidly come up to speed and mitigate most costs by the end of the first year. However, as the United Airlines experience suggests, no amount of preparation would suffice to rapidly mitigate these impacts, and the effects could be significant well after the first year following a transition. Some other assumptions are also highly conservative; for example, if multiple vendors were used, and if a new LNP vendor wrote new code instead of utilizing the existing code held in escrow, then costs in all categories would be significantly greater. The cost model assumes that the new administrator is technically competent and would not encounter as bad a transition as the episodes described in the executive summary.

III. Conclusion

A change in LNP administrator would likely impose significant costs on U.S. carriers. According to the cost model developed here, approximately $719 million in additional cost would accrue to U.S. carriers in the first year of such a transition. These costs would take the form of service credits, hands-on customer service, operations research, and additional system testing. In addition to these costs, greater service delays and errors in porting would likely cause some customers to abandon their switch to a new carrier, resulting in additional lost revenue (and increased cost per sale) from the providers that are gaining the most market share from their competitors.

The model developed here includes very conservative assumptions for error rates and testing costs, it assumes that all inefficiencies are resolved in the first year of the transition, and it does not account for opportunity costs. The latter impact could dwarf the direct costs of transition. Because LNP is fully embedded in core telecom infrastructure, a problematic transition to a new administrator could cause carriers to reallocate resources for many months from the advancement of strategic technology and business priorities to the remedial work of fixing and implementing more controls over the LNP process and repairing relations with consumers. Any such delays could have far-reaching impacts that are difficult to quantify.

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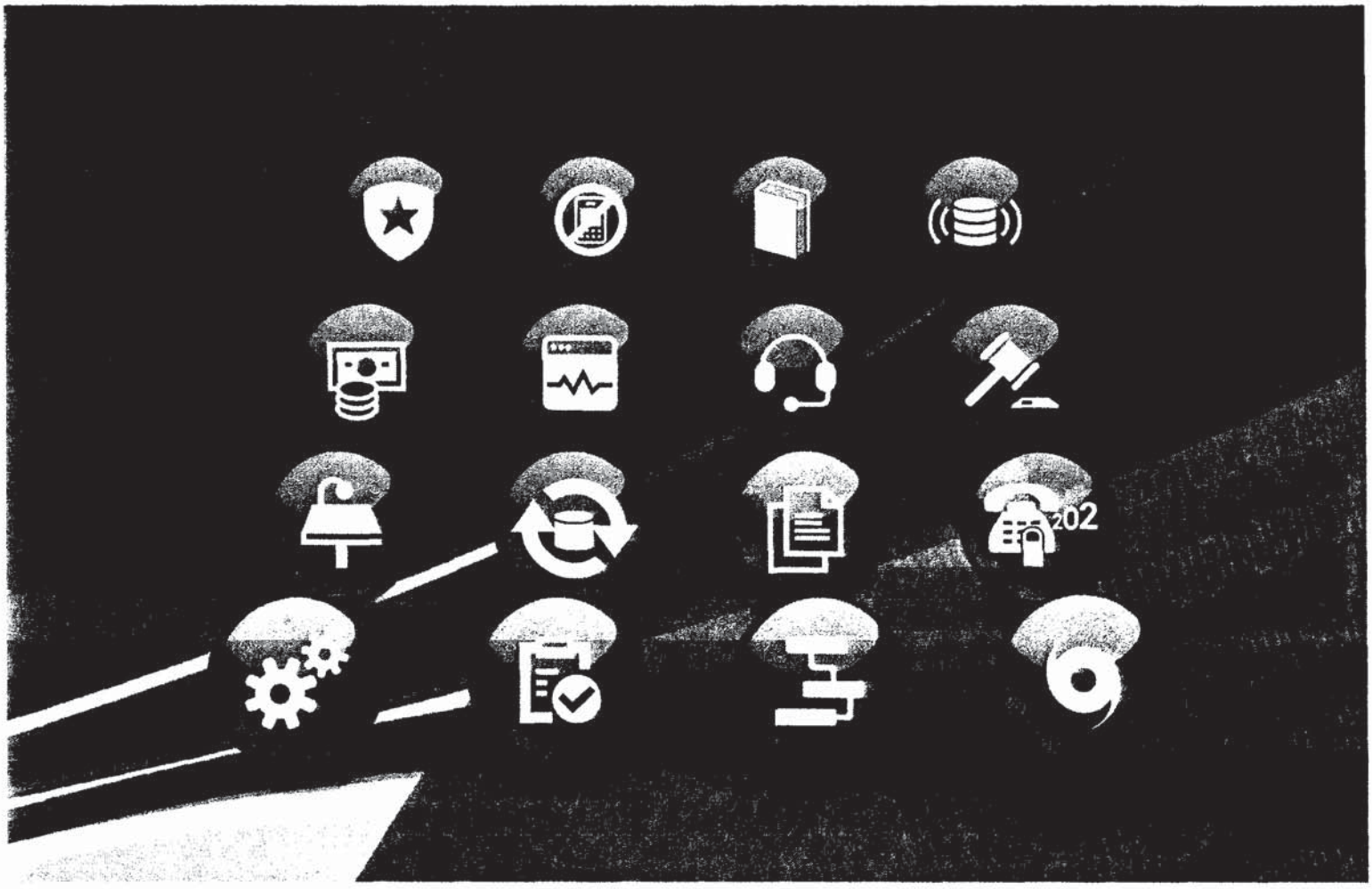
Equipment Identifier Registry (EIR) Solution



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Introduction and Market Overview

Recent studies show that by 2016, mobile phone shipments inclusive of smart phones will reach a total of 2.23 billion units worldwide. While computing power of mobile phones continues to improve, and the usage model shifts to hungry data applications, so will the probability of one's device being stolen as smart phones remain the predominant choice of consumers with newer and flashier models hitting the market every several months.

The New York Times reported that in 2011-2012, roughly one out of three robberies nationwide have involved the theft of a cell phone. The thefts have grown most rapidly in urban areas; cell phones are stolen in more than 40 percent of all robberies in New York City and 38 percent of robberies in the District of Columbia, according to the FCC and local law enforcement agencies[1].

Our findings outline the following (see Theft and Loss Model in North America in Figure 1 below):

Market Highlights:

- 1 out of 3 robberies nationwide have involved the theft of a cell phone
- 1.8B handsets shipped per year worldwide
- 78M lost/stolen new handsets worldwide per year
- Enterprise market:
  - 4.3% of all employee smart phones are lost/stolen per year
  - 6.5% of 13.2M smart phones expected to be lost/stolen in 2013 will be recovered
  - 57% of lost/stolen smart phones were not security protected
  - 60% of lost/stolen smart phones are believed to contain sensitive and confidential information

- Crimes involving smart phones will exceed 3M per year in North America by 2014
- Lost and stolen smart phones will increase commensurate with smart phone growth
- Business smart phone losses will exceed consumer smart phone losses by 2016
- Unrecovered smart phones represent 13% of all replacement sales

Theft and Loss Model in North America

Robbery Data	2011	2012	2013	2014	2015	2016	2017	2018
Thefts								
North American Population - 2012	347,262,968	350,046,827	352,853,003	355,681,675	358,533,023	361,407,229	364,304,477	367,224,950
2009 data - per 100,000 people								
Robbery		137.6	137.6	137.6	137.6	137.6	137.6	137.6
Burglary/ Larceny/ Theft		2,805.5	2,805.5	2,805.5	2,805.5	2,805.5	2,805.5	2,805.5
Extrapolated to all of North America								
Robbery		481,664	485,526	489,418	493,341	497,296	501,283	505,302
Burglary/ Larceny/ Theft		9,820,564	9,899,291	9,978,649	10,058,644	10,139,280	10,220,562	10,302,496
Total Theft		10,302,228	10,384,817	10,468,067	10,551,985	10,636,576	10,721,845	10,807,798
Estimate - % Robberies involving cellphone		40%	50%	55%	55%	55%	55%	55%
Estimate - % Burglaries, Larcenies, Theft involving cellphone		20%	25%	28%	28%	28%	28%	28%
Lost and Stolen Handset Summary								
Estimated Total crimes involving cellphone		2,156,779	2,717,586	3,013,308	3,037,465	3,061,815	3,086,360	3,111,102
Estimated Smartphones Lost (not stolen)		8,398,981	10,445,805	11,856,859	13,312,792	14,337,418	15,133,262	15,949,377
Estmated Smartphones Recovered		(687,760)	(857,660)	(968,865)	(1,065,300)	(1,133,646)	(1,187,098)	(1,241,884)
		9,868,000	12,305,731	13,901,303	15,284,957	16,265,587	17,032,524	17,818,595
Theft Ratio		1.8%	1.6%	1.8%	1.4%	1.3%	1.3%	1.2%
Loss Ratio (Before Recovered)		6.1%	6.1%	6.1%	6.1%	6.1%	6.1%	6.1%
Recovered		-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
		7.2%	7.2%	7.2%	7.1%	7.0%	6.9%	6.9%

Sources:
Population and Crime Stats: Government sources
Lost smart phone ratio: Ponemon Institute (white paper study aponsored by McAfee

Figure 1

1 "National Database Planned to Combat Cellphone Theft", New York Times, April 9, 2012

In April 2012, the FCC working with Congress, local police authorities, and wireless carriers determined the need to create a central registry to track stolen phones and prevent them from being used again on carrier networks[2].

Verizon Wireless, AT&T, Sprint and T-Mobile are working to put in place a program to disable phones reported as stolen, preventing them from being used on each other's networks[3]. This process of "blacklisting" the stolen device's IMEI prevents participating carriers for activating a stolen device on their networks.

More recently on November 1, 2012 and in support of FCC guidelines, AT&T and T-Mobile were the first U.S. carriers to share stolen phone information via a shared database[4]. By November 30, 2013, the major U.S. LTE carriers including those CDMA carriers that are deploying LTE networks (e.g., Verizon Wireless and Sprint) agreed to use a common database for stolen LTE smart phones, which will prevent any stolen LTE phone from being activated on another LTE network among these U.S. carriers. At present, these carriers have decided to use the GSMA IMEI Database for sharing the stolen serial numbers, or IMEI information.

Existing industry solutions consist of in-house, carrier-specific applications as well as and the use of the GSM Association's IMEI Database to blacklist stolen IMEIs from GSM/UMTS phones.

Our research shows that U.S. wireless carriers are opting for carrier-specific solutions for the short term. Long term, however, with the wide adoption of LTE, a shared, centralized EIR will be required to support the portability of devices from carrier to carrier. Today GSM/UMTS mobile phones can't be activated on CDMA networks and vice-versa based solely on technological limitations, but as LTE adoption spreads across the U.S. carriers, the need to distribute and receive blacklisted IMEIs among them, in real-time, at a national and global level, will become a necessity.

Based on industry requirements there is a need for a central, shared EIR to interface with and augment the existing GSMA IMEI DB, to fully extend to LTE networks and include the following:

- Ability to receive stolen IMEI information (with real-time distribution)
- Ability to report and retrieve stolen IMEIs to/from the carrier's own EIR, and update each carrier's black list (LTE and non-LTE lists)
- Ability to recall the reported stolen IMEIs after the stolen/lost phones have been recovered
- Ability to segment IMEI information based on network technology (LTE vs. non-LTE)
- Ability to segment IMEI information based on geographical area (US vs. global)
- Ability to broadcast IMEI information based on recipient's specification (e.g., any status change, only newly black listed IMEI or when a black listed IMEI becomes white listed)
- Ability to respond to queries from MNOs (notably MNO provisioning systems, during subscriber activation)
- Easy integration with existing systems
- Security and data integrity
- Database backup and recovery

2 Chairman Remarks on Stolen Cell Phones Initiative, FCC Commission Document, April 10, 2012
3 "Carriers Band to Fight Cellphone Theft", Wall Street Journal, April 9, 2012
4 "AT&T, T-Mobile First To Switch On Database To Track Stolen Cellphones", TmoNews, November 1, 2012

Figure 2 shows the benefits for using the NPAC for storing stolen IMEI information.

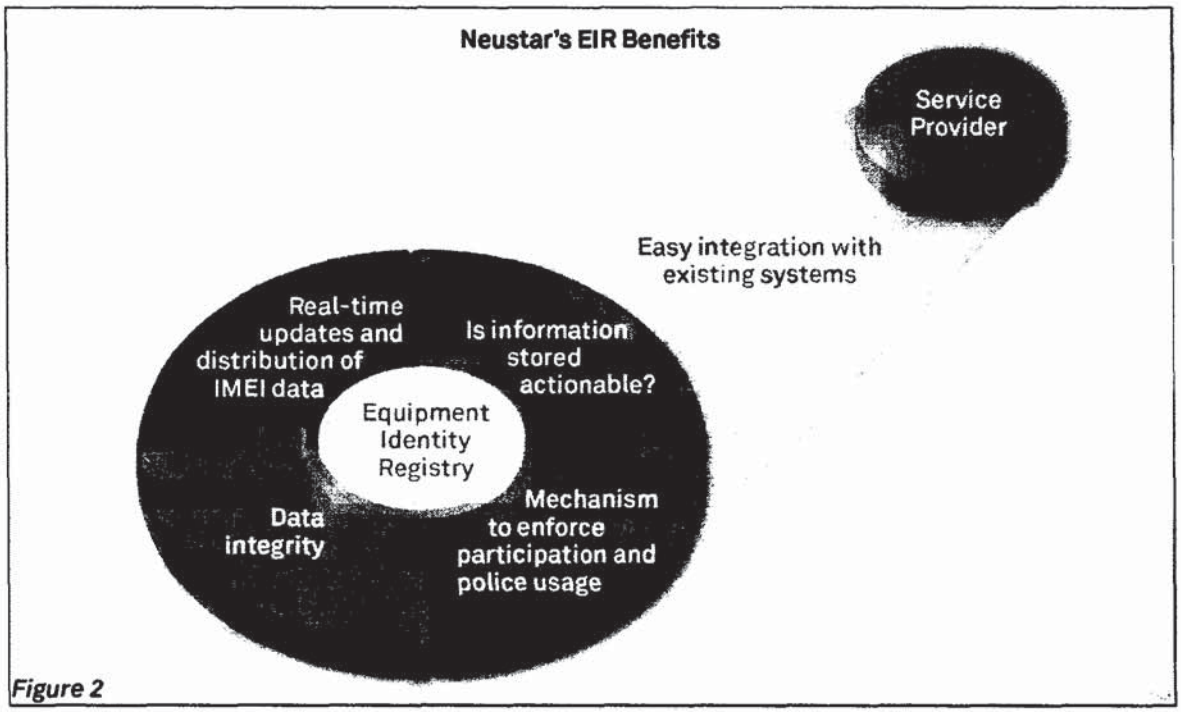

Figure 2

Neustar's EIR Solution

Neustar's approach will leverage the existing NPAC infrastructure to serve as the foundation for a new NPAC EIR service and provide a familiar and existing interface to the carriers.

The LNPA Working Group is currently finalizing specifications for NANC 372, which defines a new interface to the NPAC based on HTTPS and XML. Neustar proposes the extension of this interface to provide additional messages for provisioning, distribution, and querying of the EIR data. The new functionality will be part of the overall NPAC service, but the EIR data will reside separately from the NPAC data.

The EIR will support the following IMEI statuses: Black Listed, White Listed, Grey Listed, and Unknown Status. In addition the solution will provide validation of the IMEI data.

Solution Highlights:

- Leverage existing NPAC services
- Universally connected with carrier's EIRs and GSMA CEIR. Can be extended to CDMA EIRs
- XML interface makes it easy to interface with carriers existing back-end systems
- Proposed extension of XML interface to accommodate new functionality and analytics
- Real-time distribution of IMEI data among EIRs
- Data security and integrity
- Technology agnostic

We would like to note that this white paper discusses IMEI only for simplicity; however the solution can include the ESN and MEID used by the 3GPP2 systems.

Specifically, the NPAC EIR interface will provide the following messages as part of the XML interface:

- **Query_IMEI**— the client system provides an IMEI and the NPAC EIR Service returns the current status of the IMEI.
- **BlackList_IMEI**— the client system provides an IMEI and the NPAC EIR Service stores or updates the IMEI status to "Black Listed".
- **GreyList_IMEI** — the client system provides an IMEI and the NPAC EIR Service stores or updates the IMEI status to "Grey Listed".
- **Clear_IMEI**— the client system provides an IMEI and the NPAC EIR Service changes the IMEI status to "White Listed".
- **Download_IMEI**— the NPAC broadcasts a change in status for a particular IMEI whenever its status has changed.

Because the NPAC is regional in nature, but the NPAC EIR is not, the provisioning portion of the interface will be accessible via a connection to any NPAC region. For the broadcast portion of the interface, the Provider will indicate which LSMS region should receive the EIR downloads.

Alternatively, Neustar can offer a new instance of the interface that is not tied to any region, and is intended solely for the purpose of the EIR data. Providers can then treat this new instance of the interface as a separate region and send all EIR related requests there.

In addition to the real-time interface, the Neustar solution will also provide an FTP service that integrates with the GSMA CEIR service. The NPAC EIR service will act as a surrogate to the GSMA CEIR system, providing EIR data to the GSMA, and pulling down the CEIR data from the GSMA. Figure 3 shows Neustar's EIR architecture and its interface to the GSMA.

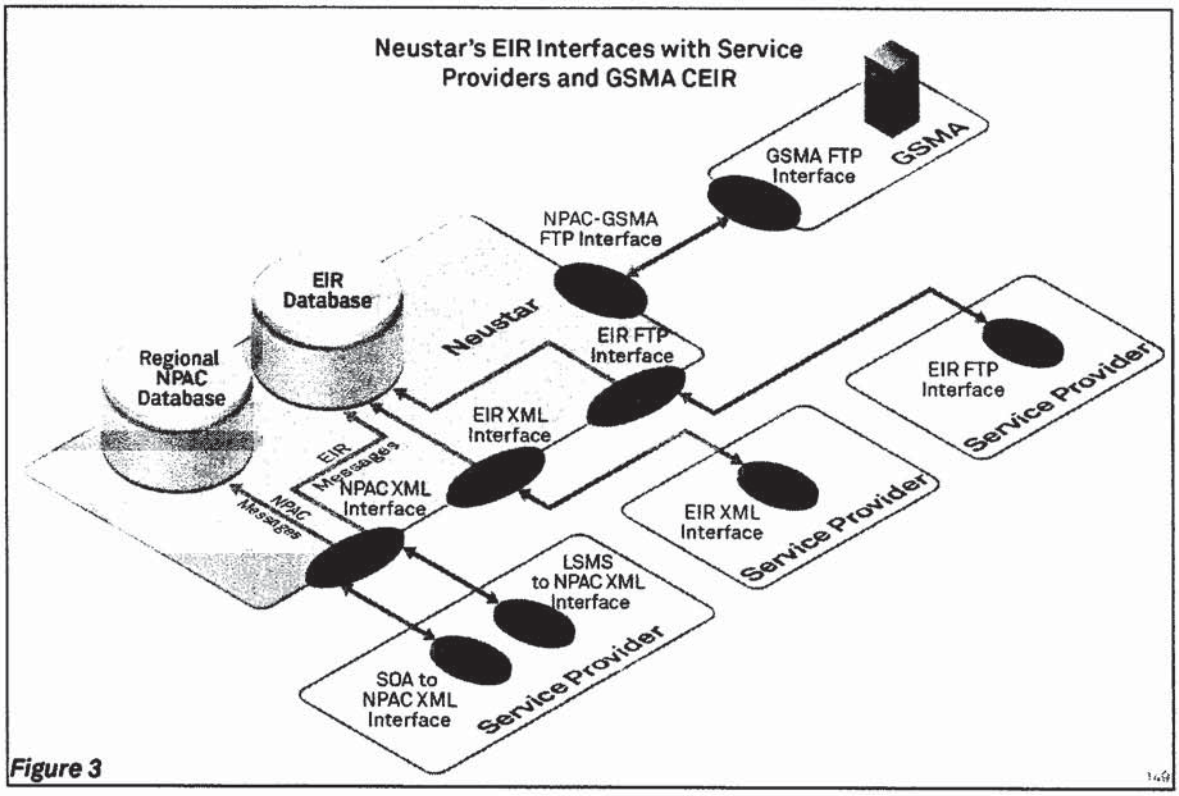

Figure 3

With this complete set of features, Neustar can accommodate any service model that customers may desire. Providers can transfer and download files to and from the Neustar service just as they do with the GSMA CEIR today. Or they can take advantage of the real-time messaging, implementing either a local EIR fed by the NPAC EIR service, or querying the NPAC EIR as needed.

The NPAC EIR service offers several benefits to Providers. First, it offers real-time access to EIR information. Second, it is based on a system architecture that is well established in the Provider's operational infrastructure. All of the communications, security and protocol support that support the NPAC will be leveraged for this new service, making it easy for Providers to integrate the NPAC EIR data with their existing systems if they so choose. Lastly, it comes with the backing of Neustar Customer Support, providing guidance, monitoring and security oversight. All of this is provided in a package that is fully compatible with the current GSMA offering, allowing Providers to take advantage of the features only when they are ready.

Future Considerations

There are several additional features that Neustar could offer to extend the value of the service.

1. The NPAC's EIR will have the capacity to track additional data associated with the IMEI, such as the TN, IMSI, SPID and date/time that White/Grey/Black Listed the device, or the technologies supported by the device. This could help Providers make smarter decisions about how to use the data. Providers can also filter the information they choose to receive based on technology designation (e.g., LTE and non-LTE capable devices) and/or geographical area (e.g., US or global).
2. The NPAC EIR could store a PIN with the IMEI at the time of Black/Grey Listing. This could facilitate the orderly removal of the IMEI from the Black/Grey List if a device recorded as stolen or lost is recovered.
3. When applicable, the NPAC EIR could interface with other CDMA regional or national EIRs to exchange EIR data on stolen devices.
4. The NPAC EIR could be made available to entities other than current NPAC customers. The proposed system leverages the NPAC to make it easy for current NPAC customers to access the new functionality. However, because the NPAC EIR itself is separate from the NPAC, Neustar could offer a separate interface that only presents the EIR specific messages, and bypasses the NPAC entirely. This way, entities such as retailers, manufacturers, insurers, and international Service Providers could enjoy the benefits of the system as well.

Benefits to the Industry

Leveraging existing NPAC services Neustar's EIR solution allows Service Providers to use existing technology and easily share stolen device information in real time, in a highly secure and universally interconnected environment.

The solution accommodates existing 2G/3G needs as well as LTE, allowing Service Providers and other approved users of EIR data to upload and query a central database. Service Providers have the potential to add functionality, new fields, and new business rules that the entire EIR eco-system can leverage in real-time.

Abbreviations Used in This Document

Acronym	Definition
2G	Second Generation
3G	Third Generation
4G	Fourth Generation
3GPP2	Third Generation Partnership Project Two
CDMA	Code Division Multiple Access
CEIR	Central Equipment Identity Registry
DB	Database
EIR	Equipment Identity Registry
FCC	Federal Communication Commission
FTP	File Transfer Protocol
GSM	Global System for Mobile Communications
GSMA	The GSM Association
HLR	Home Location Register
HTTPS	Hypertext Transfer Protocol Secure
IMEI	International Mobile Equipment Identifier
IMSI	International Mobile Subscriber Identity
IP	Internet Protocol
LRN	Local Routing Number
LSMS	[redacted]ystem Management Service
LTE	Long Term Evolution
MAP	Mobile Application Part
M2M	Machine to Machine
MEID	Mobile Equipment Identifier
MNO	Mobile Network Operator
NANC	North American Numbering Council
NP	Number Portability
NPAC	Number Portability Administration Center
PIN	Personal Identification Number
SPID	Service Provider ID
STP	Signal Transfer Point
TN	Telephone Number
UMTS	Universal Mobile Telecommunications System
XML	Extensible Markup Language

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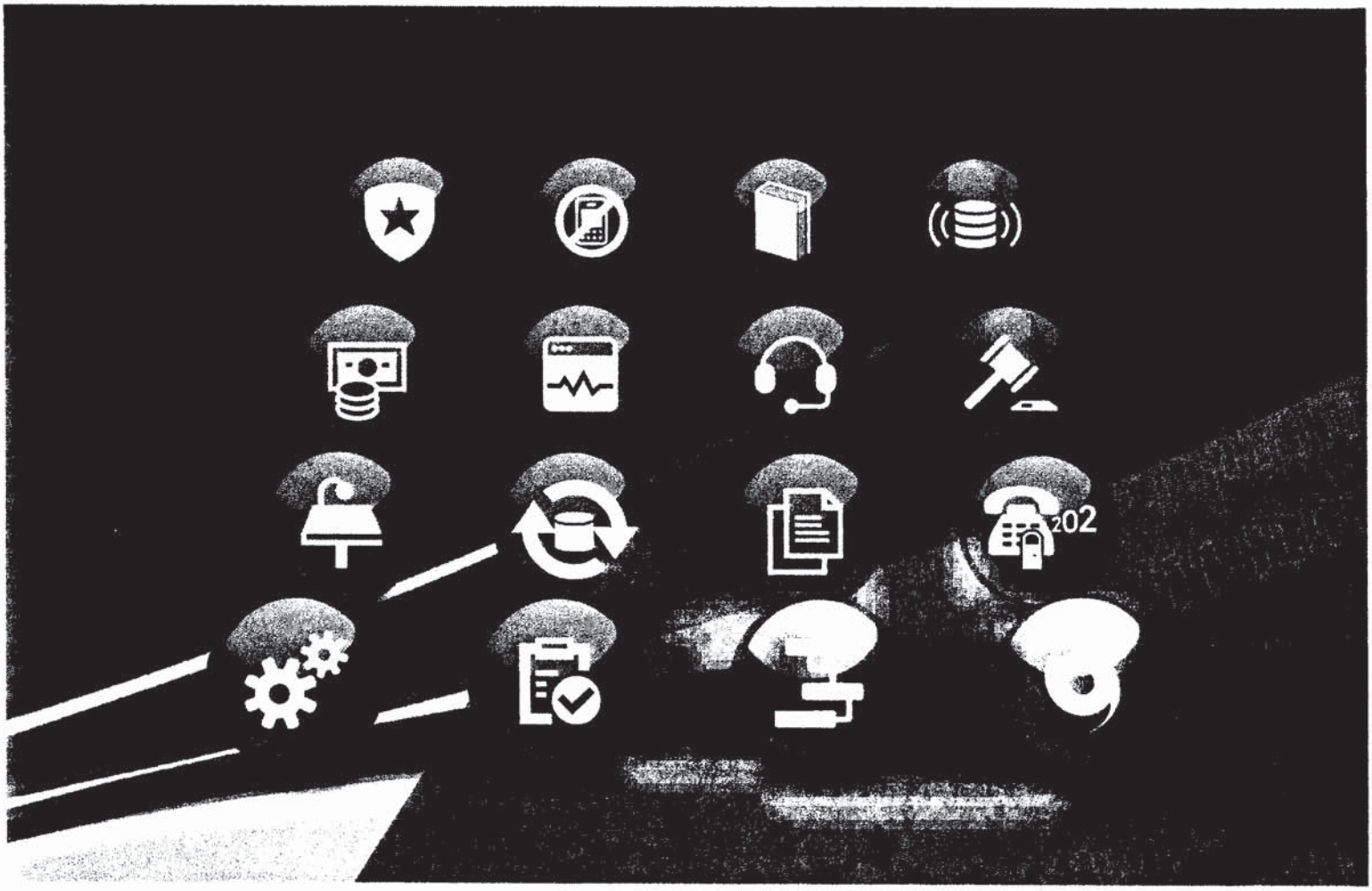
M2M Number Administration, Interoperability, and Service Enablement



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Introduction and Market Overview

Solution Highlights:

- M2M devices will strain current TN supply and rely more heavily upon non-geographic area codes and 5YY numbers that are not interoperable
- M2M solutions are delivered in silo'd environments and fail to interoperate with a broader community of users
- NPAC can use URI fields to enable interoperability for both 5YY TNs and geographic TNs

Recent advances in wireless communications, embedded systems, and IP networking are spurring the growth of Machine-to-Machine (M2M) communications and services. M2M solutions are envisioned to connect billions of existing and new devices, ranging from high-end smart mobile devices to low-cost resource constrained wireless sensors. According to some estimates, there will be nearly 500MIL connected devices in the US, by year 2020. M2M technology can be beneficially applied to a broad range of use cases for smart grids, telematics, eHealth/mHealth, fleet management, industry control, home automation, and environmental monitoring.

Most M2M devices today are addressed using telephone numbers (TNs). However, there are challenges with the use of TN-based identfiers and addresses for these devices. Today they use either geographic TNs or TNs in the 5YY range. 5YY numbers have a downside in that they are not routable between networks They were never integrated into the PSTN and therefore are really just a private numbering space. At least some applications will require interoperability.

Regulators are getting concerned that demand for TNs for M2M may deplete their existing geographic area codes, causing new area codes to be added, and even exhaust of the entire NANP, which would require an expansion beyond 10 digits for NANP TNs.

As M2M cellular connects continue to rise, so does the fear that an unprecedented increase in telephone number demand will strain the current supply of NPAs. To better understand the M2M demand for telephone numbers, Neustar has developed forecasting models that predict TN exhaust by adding M2M TN demand on top of NRUF TN forecasts. The models developed forecast TN exhaust from a national level down to specific area codes seeking relief in the next five years as forecasted by NRUF (the most granular level of TN exhaust data available). The key driver for these models centers on a U.S. based, cellular M2M devices, all of which require a Telephone Number.

The national forecasting model builds upon the NRUF model by applying the annual demand of M2M devices against the long term NPA supply. Currently, NRUF estimates NPA usage with a straight line demand of approximately five NPAs per year. To be consistent, the M2M device usage was also calculated to a NPA unit by dividing the total incremental annual M2M demand by eight million, or the number of potential TNs in each area code. This resulted in the number of additional area codes that would be consumed by M2M. Together, the annual M2M device demand and NRUF forecast resulted in the existing NRUF forecast of TN exhaust by 2042 to run out 12 years earlier, or more than 40%, with forecasts of TN exhaust now pegged to 2030.

The area code exhaust model focuses on individual area codes already identified by the NRUF forecast to require relief within the next five years. The M2M demand is applied within each area code to highlight its impact. To properly apply M2M TN requests within each area code, the total U.S. M2M demand was normalized down to a common denominator based on the resident population of the U.S. For each year, the number of M2M devices was divided by the U.S. population to calculate an average M2M device per individual. This average M2M device per individual was then applied to each area code by multiplying it against its resident population. The aggregated M2M demand affects individual area codes by pulling in the year in which relief is required, years ahead of its original

forecast. The effects are dramatic from a resource planning perspective.

Currently based on NRUF exhaust tables, 75% of carrier relief expenditures would be required in 2015-2017. With the additional M2M demand, however, these same area codes will now require over 95% of the expense to be carried in 2013-2014 with 80% of the costs now needed in 2013. This disruptive funding shift will rattle many carriers' short term budgets and cause unplanned allocation of funds from other strategic programs. It should only be presumed that all remaining area codes would experience a similar shift in cost expenditures due to M2M TN growth, pulling into the near future unanticipated expenditures.

It should be noted that M2M demand is not leveled out across all areas codes, but rather tend to quickly amass in a small geographical area with a magnified affect on TN demand. This uncertainty applies a random probability to TNs usage and hampers the ability to accurately forecast exhaust.

The industry is in a difficult positon and it needs to continue to use TNs for some time, because any alternative identifier/address will be years away from having an impact, while not exhausting important existing resources.

Another problem with the current M2M solutions is that they are delivered in "silos" in an "over-the-top" (OTT) manner. While the network still provides connectivity services, most of the other services and application layer functionality is delivered by an M2M Service Delivery Platform (SDP) hosted by the application Service Provider. In this model, the set of devices and their users are pre-defined by the application and the interoperability between them is typically established through an "app" on the users' smartphone. As an example, in a home energy control application, the residents from the home download the "energy control app" on their smartphones which allows them access to the device for monitoring and control purposes. If the home owner needs to have the appliance manufacturer access the device "on demand" to diagnose a particular problem with the appliance, it is difficult to enable such access within the current M2M application framework because the application essentially behaves in a "closed" manner. Interoperability and access is limited to the users of the app.

Lack of openness and interoperability will prevent the promise of M2M services from being fully realized; an undesirable situation that the industry needs to address. Figure 1 shows the OTT M2M service delivery concept that is described above.

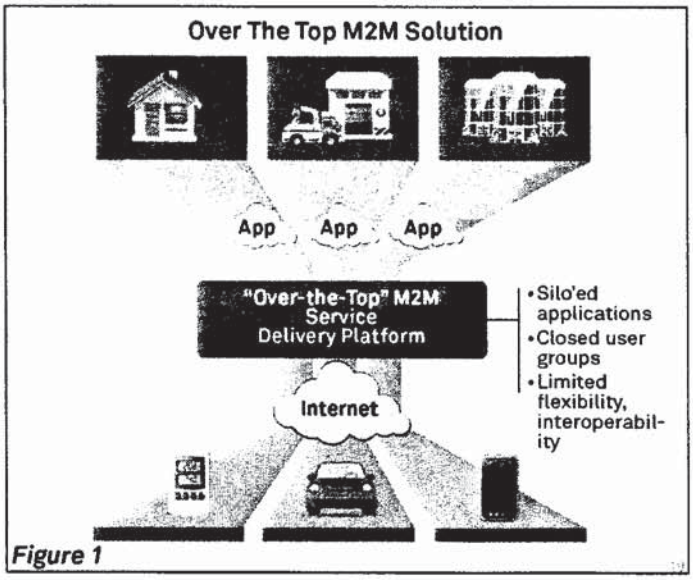


Figure 1

The industry needs to address the following issues in the near future:

- Administering TNs associated with M2M in a way that conserves this important industry resource
- Enabling interoperability for 5YY TNs
- Enabling interoperability between users across any network and M2M devices for all TNs
- Enabling the development of M2M applications that are open and flexible across a broad set of user communities

The NPAC can be the enabling platform for providing both administration and interoperability of M2M devices, applications, and users related to TNs.

Neustar's Solution

The industry should take advantage of the NPAC's inventory administration capabilities, thousand block pooling, to also administer M2M TNs. The NPAC can track the assignments and ensure that the resources are being used efficiently. A new M2MURI field should be added to the NPAC and used to enable interoperability for both 5YY TNs and geographic TNs. The existing URI fields can be used for IP interoperability and SMS message routing to enable message based communication between users and devices.

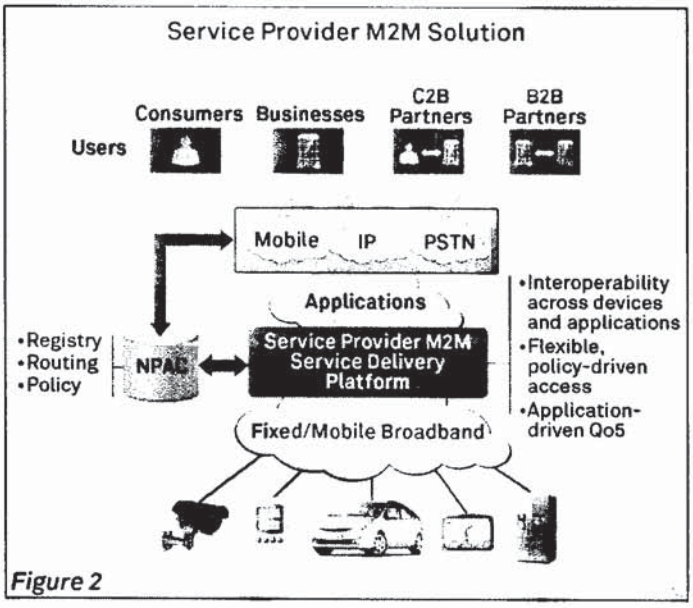


Figure 2

The NPAC can also become the enabler for a more flexible M2M Service Delivery Platform for Service Providers that can support a broader set of open applications than what is currently possible with the OTT Platforms. This more flexible Service Provider enabled solution is shown in Figure 2.

In this architecture, applications can be developed to provide more flexible access to users of different communities based on rules and policies defined by the "owner" of the application. Using the previous example of home energy control, the home owner can set rules for allowing access to the appliance manufacturer or servicing agent (shown as a "consumer-to-business (C2B) partner") to remotely diagnose the home appliance. The access can be enabled via mobile, IP, or PSTN networks from any device, but subject to proper authentication by the M2M SDP.

The NPAC can also enable the concept of telephone number "NAT-ing". This would enable multiple M2M services to be deployed by multiple Service Delivery Platform's using the single public telephone number as the key to all of the M2M services. This enables a plethora of M2M services to be delivered while preserving telephone numbers.

By adopting an M2M SDP that enables a wider set of interoperability between users and M2M

devices, Service Providers will be in a position to attract the application developer community with a more powerful set of APIs. This will unleash a large number of new applications that can drive faster adoption of M2M services, thereby generating increased revenue streams for Service Providers.

Benefits to the Industry

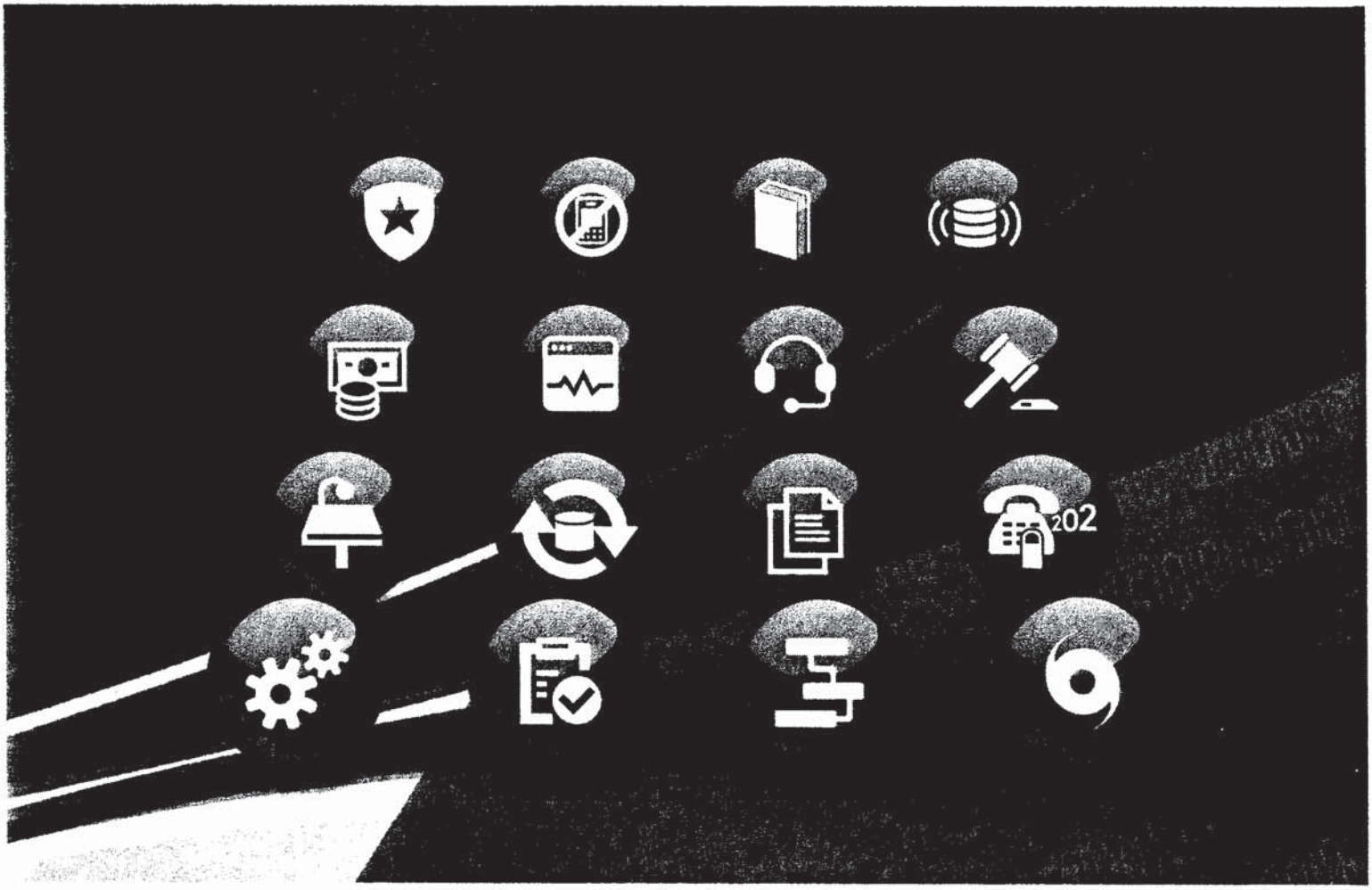
M2M is a significant opportunity for communications Service Providers to generate new revenue. The use of TNs is a requirement for many M2M applications and for connected devices because the current infrastructure requires it. However excessive demand for TNs for M2M may create regulatory issues. In addition the need for interoperability will require an efficient and effective solution. To take advantage of these opportunities the industry needs to proactively address issues regarding resource exhaust and interoperability so it can continue to provide these innovative solutions uninterrupted. The NPAC is the right platform for enabling any future capabilities for TNs. The upgrade to a web services interface will make it much easier to manage the enabling IP capabilities.

M2M service enablement is a lucrative growth area for Service Providers. However, the market currently is highly fragmented by OTT application providers. By leveraging their network assets and adopting a service delivery platform that enables broader interoperability and access to a wide spectrum of users, Service Providers can unleash the full potential of the M2M market. By virtue of its global registry and routing capabilities, the NPAC can readily enable a new breed of M2M services for the industry's benefit.

Abbreviations Used in This Document

Acronym	Definition
5YY	Special-purpose telephone numbers contained in area code 500, 533, 544, or 566 and used for "follow me" personal communication services
C2B	Consumer to Business
IP	Internet Protocol
M2M	Machine to Machine
NANP	North American Numbering Plan
NAT	Network Address Translation
NPAC	Number Portability Administration Center
NRUF	Numbering Resource Utilization/Forecast
OTT	Over-The-Top
PSTN	Public Switched Telephone Network
SDP	Service Delivery Platform
SMS	Short Message Service
TN	Telephone Number
URI	Universal Resource Identifier

SMS Message Routing - Landline Numbers



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Introduction and Market Overview

Over the last few years IP technology has enabled Short Message Service (SMS) capability to be extended beyond mobile devices. Because of these changes many types of new SMS providers have entered the marketplace. These new entrants use telephone numbers obtained from Landline service providers. This has created a problem for SMS messages that are destined to these Landline numbers because Wireless operators do not recognize these numbers as being SMS capable. By default, Wireless operators consider Landline numbers not to be capable of SMS.

Today, the Messaging ecosystem uses mutliple sources of data to enable SMS routing, but the main source of data is the Number Portability Administration Center (NPAC). By default, all telephone numbers that have the SV Type field populated with Wireless are automatically included into the Messaging ecosystem as SMS capable.To date, there has not been a consistent, transparent method of indicating a Landline telephone number's SMS capabilty as exists for Wireless numbers. The current method of whitelisting Landline numbers (Figure 1 below) is disjointed, largely proprietary and administered by mutiple organizations within the industry.

The industry needs to address the following issues with respect to indicating the SMS capability of Landline numbers:

1. Indicate the SMS capability of Landline numbers in a consistent, centralized manner using a non-proprietary database
2. Insure transparency exists and the entity responsible for SMS on each telephone number can be identified
3. Provide tools to users to be able to access the centralized database
4. Protect the telephone number assets of carriers
5. Insure that any solution is aligned with number portability

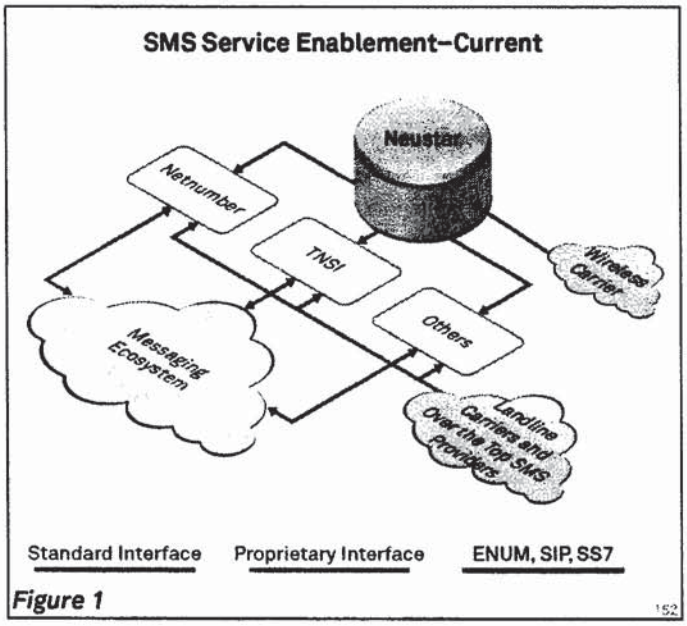

Figure 1

The NPAC can be an enabling platform for indicating and identifying SMS capable Landline telephone numbers. The NPAC can facilitate SMS service to those numbers in a manner that solves today's messaging ecosystem problems.

Neustar's Solution

NPAC's existing TN inventory administration capabilities along with the SMSURI field and can be used to also administer Landline SMS capable telephone numbers in the same database that manages Wireless telephone numbers.

The NPAC can be the central location to identify numbers that are SMS capable and distribute this data to the messaging ecosystem. The information populated in the SMSURI field will be consumed by

relevant Service Providers and mapped to current route information using various types of SPIDs. No changes are required to how current SMS routes. This will enable easy and open access to determine the entity actually responsible for the SMS. The information can be obtained via tools such as PortPS which is available at no cost to NPAC users.

Neustar's proposal (depicted in Figure 2) does not require changes to how SMS is routed today, this only affects how the telephone number used to route SMS is made SMS capable (aka whitelisted). The information stored in the SMSURI field is flexible and has no specific limitations as to syntax. By populating the SMSURI field the SMS Service Providers (Carriers and Over The Top) agree to be in compliance with Section 4.1 of the CTIA SMS Interoperability Guidelines Version 3.2 (http://www.ctia.org/business_resources/index.cfm/AID/12056.)

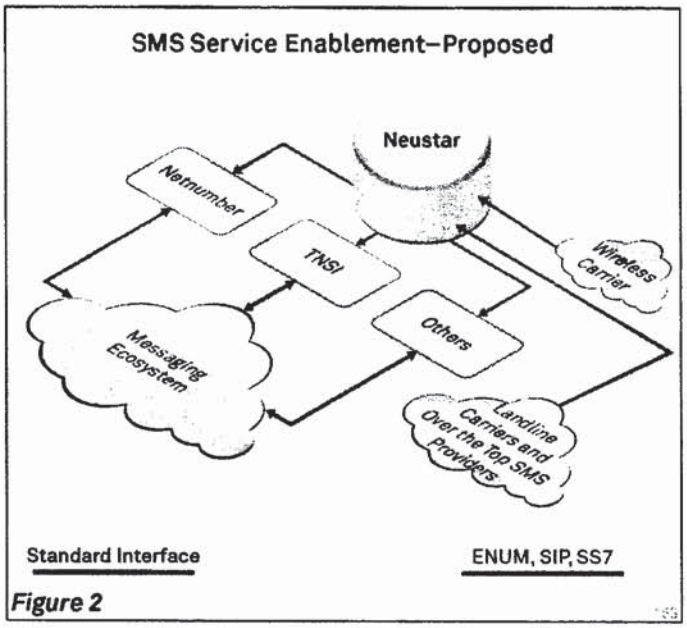

Figure 2

The following use cases are described below:

- Landline operator directly offering the SMS service to their subscriber base
- Reseller or Over-The-Top provider offering SMS services to their subscriber base

Landline Operator Directly Offering SMS Service

In this use case, the Landline operator (CLEC, ILEC, or Cable) will offer an SMS service directly to their subscriber base. The SMS service may be operated by a designated 3rd party, but the service is using the Landline operator's telephone numbers.

The following parameters are needed:

- Landline operator has a SPID value of 1234 that is associated with their numbers in the NPAC.
- Landline operator (or their designated 3rd party that is providing SMSC services) is using Inter-Carrier Vendor, ICV-A.
- The messaging ecosystem has route tables built that map SPID 1234 to ICV-A. ICV-A maps SPID 1234 that contains an SMPP bind to Landline operator SMSC (or their 3rd party SMSC)

The following steps occur when the Landline operator wishes to SMS enable their subscriber's telephone number.

1. Landline operator updates the SMSURI field in the NPAC with a value of sms.landlineoperator.com (note: this field is flexible and the syntax is flexible to what the industry needs)
2. Changes to the SMSURI field are distributed by the NPAC to all NPAC users, including the messaging ecosystem databases

3. The telephone number is now SMS capable and SMS will route to the Landline operator' SMSC (or 3rd party SMSC) via ICV-A

Reseller or Over-The-Top Provider Offering SMS Service

In this use case, the Landline operator (CLEC, ILEC, or Cable) will allow non-carriers to use their telephone numbers in order to offer SMS services.

The following are the parameters of the use case for OTTCo, the entity offering the SMS service and Landline operator, the entity that leased the telephone number to OTTCo:

- Landline operator has a SPID value of 6789 that is associated with their numbers in the NPAC
- OTTCo has a SPID of E123 inside the messaging ecosystem
- OTTCo is using Inter-Carrier Vendor, ICV-A
- The Messaging ecosystem has route tables built that map SPID E123 to ICV-A. ICV-A maps SPID E123 that contains an SMPP bind to OTTCo SMSC

The following steps occur when OTTCo wishes to SMS enable their subscriber's telephone number:

1. Landline operator updates the SMSURI field in the NPAC with a value of sms.ottco.com (note: this field is flexible and the syntax is flexible to what the industry needs)
2. Changes to the SMSURI field are distributed by the NPAC to all NPAC users, including the messaging ecosystem databases
3. The telephone number is now SMS capable and SMS will route to OTTCo SMSC via ICV-A

Benefits to the Industry

Messaging (SMS and MMS) is a significant revenue source for the Industry. It is important to have Landline numbers SMS-enabled in a similar fashion to how Wireless numbers are SMS capable. This solution will make transparent all numbers that are SMS capable as well as the entity offering the SMS service behind the number. This transparency will enable the Industry to identify SPAM origination and make it easier to stop.

The SMSURI field is already in the NPAC and is being used today. There is no additional cost to the industry for using the NPAC to SMS-enable Landline telephone numbers. Neustar will work closely with Landline carriers and Over the Top providers to minimize any changes to existing white list processes. Lastly, this solution requires no changes to current processes used by Wireless carriers.

Abbreviations Used in This Document

Acronym	Definition
CLEC	Competitive Local Exchange Carrier
CTIA	Cellular Telecommunications Industry Association
ICV	Inter-Carrier Vendor
ILEC	Incumbent Local Exchange Carrier
IP	Internet Protocol
NPAC	Number Portability Administration Center
SPID	Service Provider ID
SV	Subscription Version
SMPP	Short Message Peer-to-Peer
SMS	Short Message Service
SMSC	Short Message Service Center
TN	Telephone Number
URI	Universal Resource Identifier

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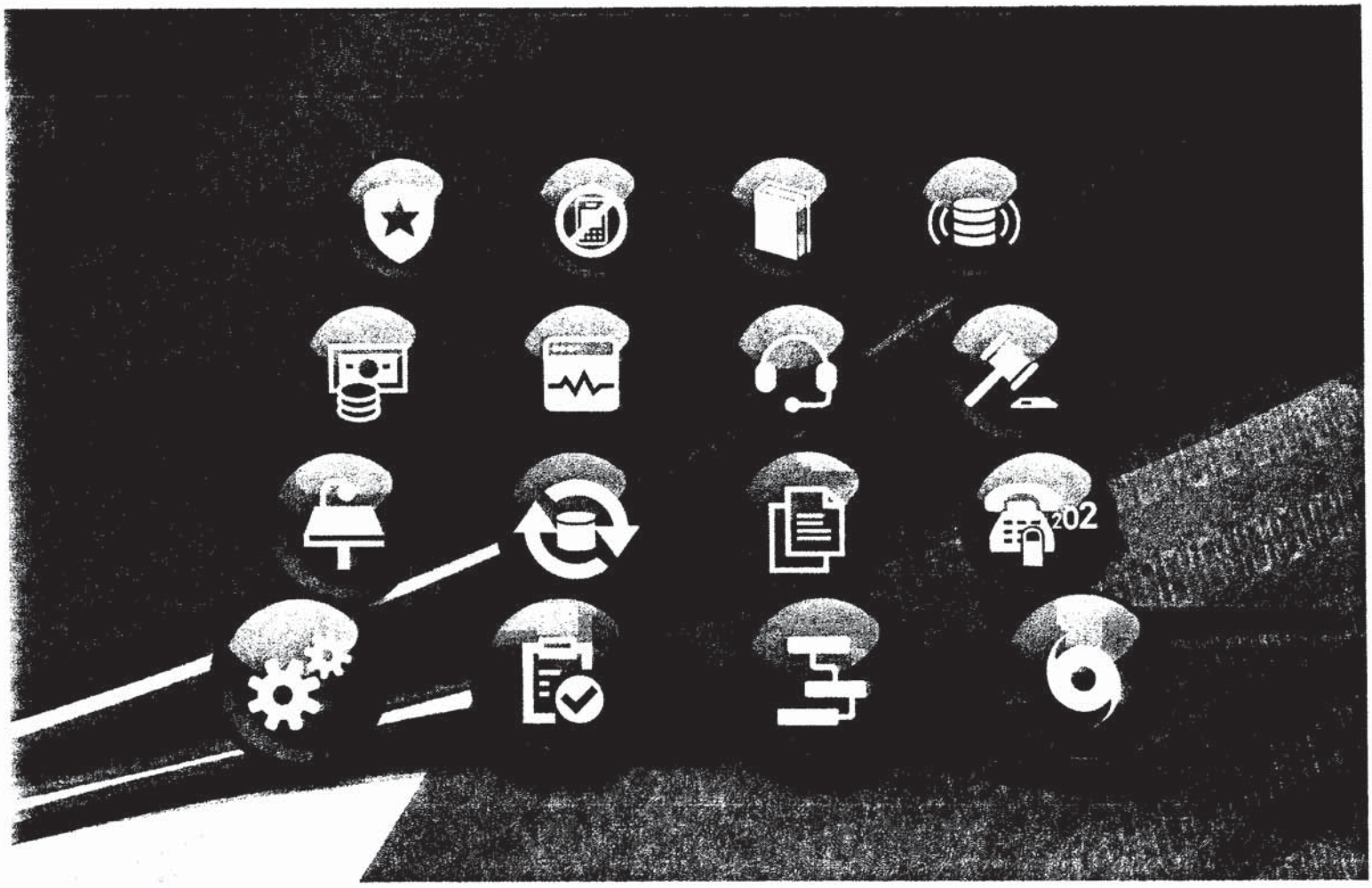
Enhancing NPAC's Role in Dynamic Addressing and Routing



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Introduction and Market Overview

The ongoing introduction of the Voice Over LTE (VoLTE) IP calling technology in mobile networks promises to enhance the mobile customer experience through the use of HD voice and reduce operating costs by carrying all voice traffic over more efficient, digital networks. Neustar has identified the opportunity to make handset roaming even more efficient under the LTE paradigm by making information visible to originating carriers which can then route the calls directly to the appropriate LTE or 3G network. This enables optimal call routing and cost savings for the industry.

Highlights:

- Optimal call routing
- Efficient use of network resources
- Improve voice quality over LTE
- Leverage the NPAC to update and disseminate handset network registration information

As consumers migrate to bandwidth intensive smart phones and the myriad of available data driven applications, mobile operators have similarly turned to an end-to-end IP based solution, LTE, to more efficiently deliver broadband data and help drive down their operational costs. LTE is an all IP architecture wherein voice, data, video services, and other rich media communications services based upon the 3GPP IP Multimedia Subsystem (IMS) standard. The IMS based voice solution in LTE networks is often referred to as VoLTE, or Voice Over LTE. Figure 1 shows a high level architecture of VoLTE:

Voice Over LTE Architecture

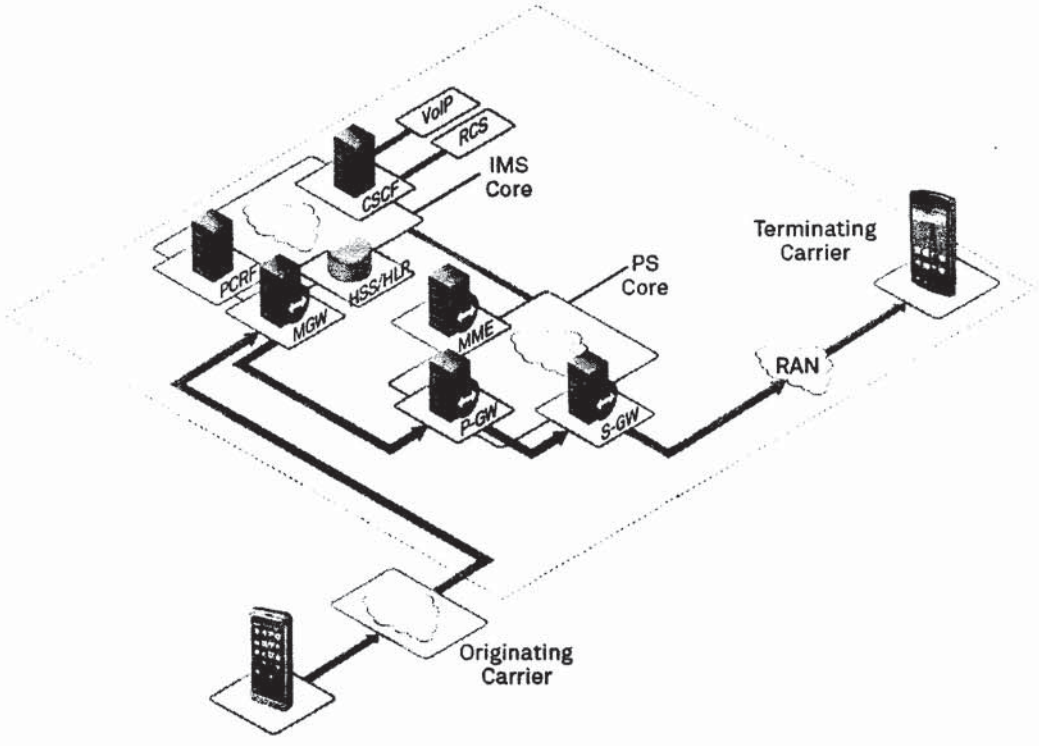

Figure 1

The IMS Core consists of the following main elements: the Session Control Entity (CSCF) that holds call state and is responsible for routing of the call and supporting application services, the subscriber

database (HSS/HLR), the Policy Control Entity (PCRF) that holds the rules for call handling, and the Media Gateway (MGW) that converts the media and signaling between IP and circuit, and connects with external networks for inbound and outbound calls. The S-GW, P-GW and MME are entities in the packet domain that handle the connection of the handset to the LTE network including handovers and mobility management.

VoLTE handsets are addressed by TNs but when they register with the HSS/HLR, they are also assigned an IP address. Incoming calls from another network are routed to the MGW, which sends the call to the CSCF, which then routes it to the handset if the handset is registered in the VoLTE domain.

Currently, most carriers have not enabled VoLTE as their voice mechanism, rather relying upon legacy 2G or 3G technologies to carry voice traffic. The migration to VoLTE will enable the eventual decommissioning of legacy networks to dramatically reduce the cost of multiple network technologies as well as free up valuable spectrum for more spectral efficient LTE. The deployment of VoLTE will most likely be market based, thus creating scenarios where, VoLTE coverage will not be available in all regions of the carrier's network. When a VoLTE user roams out of their home VoLTE network into a non-VoLTE coverage area, their device will attach to the existing 3G network in that area instead. Once the handset registers with the MSC/VLR of the 3G network, the LTE HSS/HLR is updated with the new routing information. However, any external or competitive network will not be aware of the device's new network location, therefore these networks will continue to route the originating call to the MGW of the VoLTE domain. It is only through the updated HSS/HLR routing information that the CSCF knows about the new point of attachment of the user device and will re-route the call through another MGW connecting the 3G network. This roaming scenario along with the new call path is shown in Figure 2.

Normal Routing for VoLTE Devices Outside of VoLTE Coverage

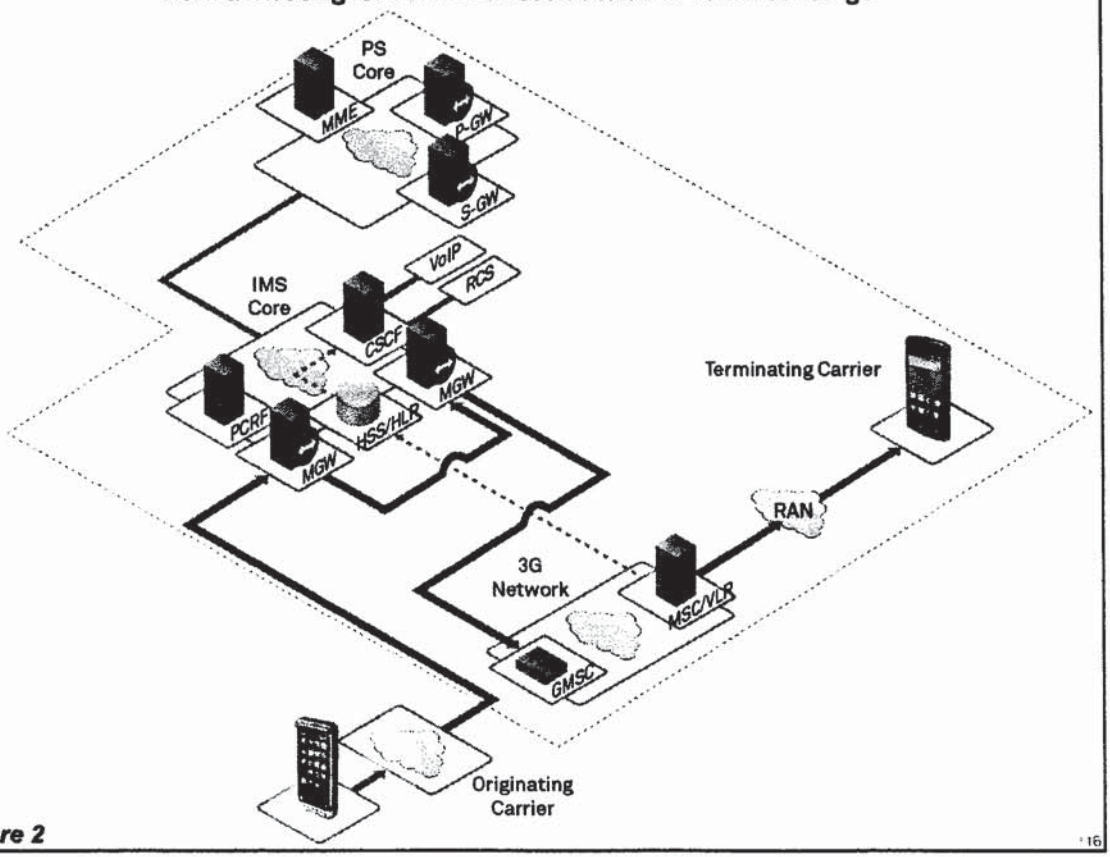

Figure 2

The current call path within a carrier's 3G and 4G VoLTE network makes inefficient use of network resources; in particular it uses two additional MGW ports that add infrastructure cost, which can be avoided by routing calls directly to the 3G network without traversing through the IMS network so it can terminate in the 3G network. In addition to the incremental cost of the MGW ports, the call quality could potentially degrade due to the added latency of the trombone effect and the back-to-back circuit-to-packet media conversions at the two MGWs. Poor voice quality can lead to abandoned calls and declining customer satisfaction.

Neustar's Dynamic Routing Solution

The inefficient routing of calls within a carrier's VoLTE and legacy circuit switch networks can be avoided if the updated routing information, as the handset roams between networks, can be made visible to the originating carrier who can then route the call directly to the 3G network's gateway MSC. As shown in Figure 3, the NPAC is the ideal vehicle to update and disseminate the handset's network registration information to all the carriers to enable optimal call routing.

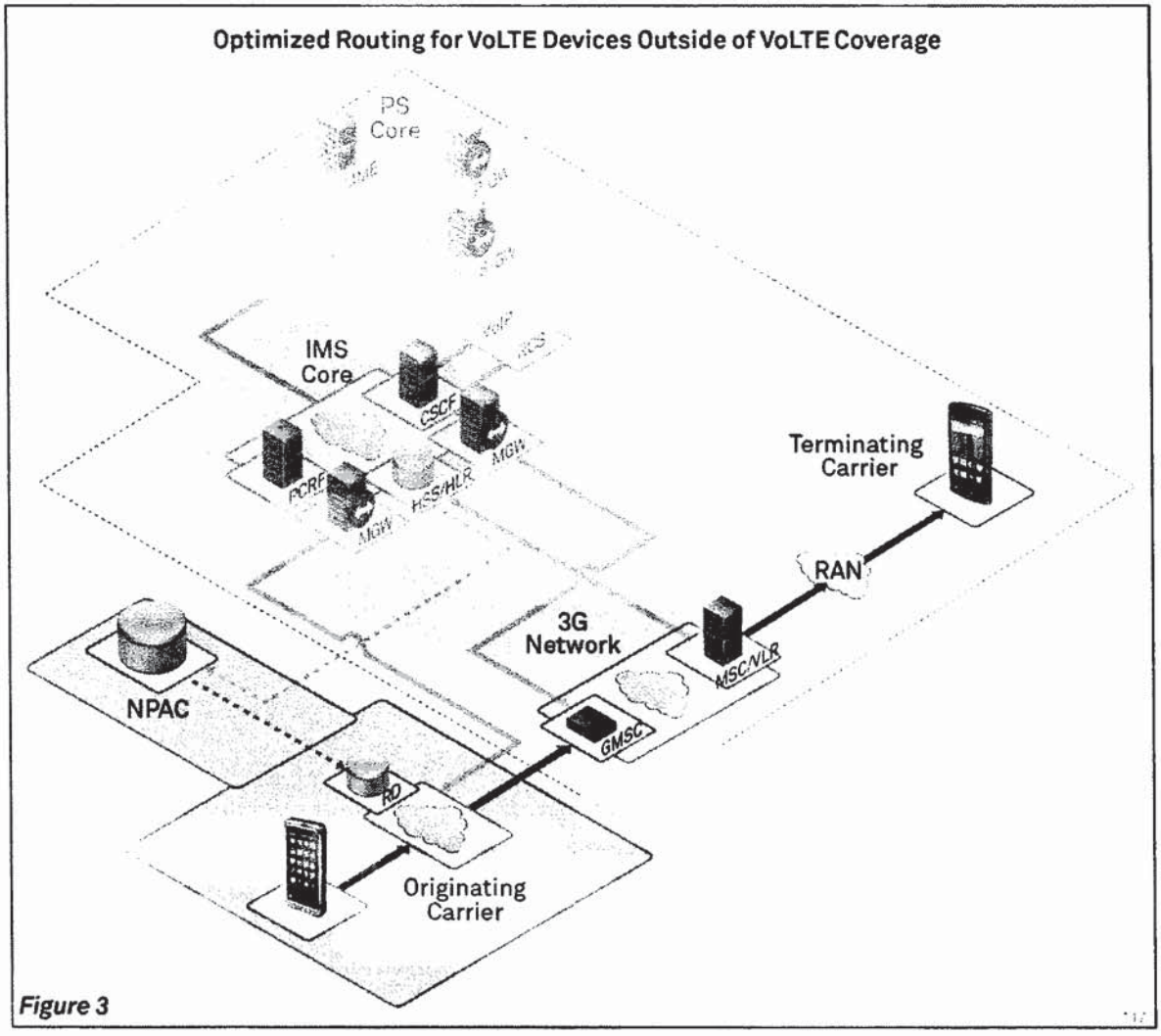

Figure 3

The proposed NPAC-based solution describes how the NPAC can be used in determining VoLTE and 3G coverage while subscriber is roaming:

The wireless Service Provider establishes an alternate LRN for LATA within the LTE coverage area, to signify the Gateway MSC of the 3G network.

When the user moves out of the LTE overage area into 3G network, the MSC/VLR updates the HSS/HLR database with the new registration information.

A new NPAC module will subscribe to the registration state update in the HSS/HLR. Upon receipt of an update, this new module will update the NPAC/SMS for the affected TN with the new 3G LRN through either:

- A Modify transaction, when the TN already has an active, non Pseudo-LRN SV in the NPAC, or
- A Create/Activate transaction, when the TN is not in the NPAC within an Active Pooled Block, or has a Pseudo-LRN SV

The NPAC will distribute the updated LRN information to other carrier networks through the LSMS broadcast. Based on this new routing information, the originating carrier will route the call directly to the Gateway MSC of the 3G network as shown in the Figure 3, bypassing the LTE network and avoiding extra steps to route to LTE.

When the user moves back into the home LTE network, the HSS/HLR is updated with the new user registration. This updated information is again obtained by the NPAC and propagated into other carrier networks to revert the routing back to the normal case.

Benefits to the Industry

We have addressed the problem of optimal routing for calls to a VoLTE device when the user roams outside the VoLTE coverage area into a 3G network. The proposed solution based on new updates to the NPAC as triggered by the HSS/HLR registration updates, allows for optimal call routing when the user is attached to a 3G network.

With our proposed solution, the incremental cost to deploy additional MGW ports will be eliminated for non-LTE roaming situations. Notwithstanding, all carriers migrating to VoLTE will encounter these capital expenditures that can now be avoided with the NPAC solution.

Abbreviations Used in This Document

Acronym	Definition
2G	Second Generation
3G	Third Generation
3GPP	Third Generation Partnership Program
CSCF	Session Control Entity Function
HD	High-Definition
HLR	Home Location Register
HSS	Home Subscriber Server
IMS	IP-Based Multimedia Subsystem
IP	Internet Protocol
LATA	Local Access and Transport Area
LRN	Local Routing Number
LTE	Long Term Evolution
MGW	Media Gateway
MME	Mobility Management Entity
MSC	Mobile Switching Center
NPAC/ SMS	Number Portability Administration Center/Service Management System
PCRF	Policy Control Entity Function
P-GW	Packet Gateway
SV	Subscription Version
S-GW	Serving Gateway
VLR	Visitor Local Registry
VoLTE	Voice Over LTE

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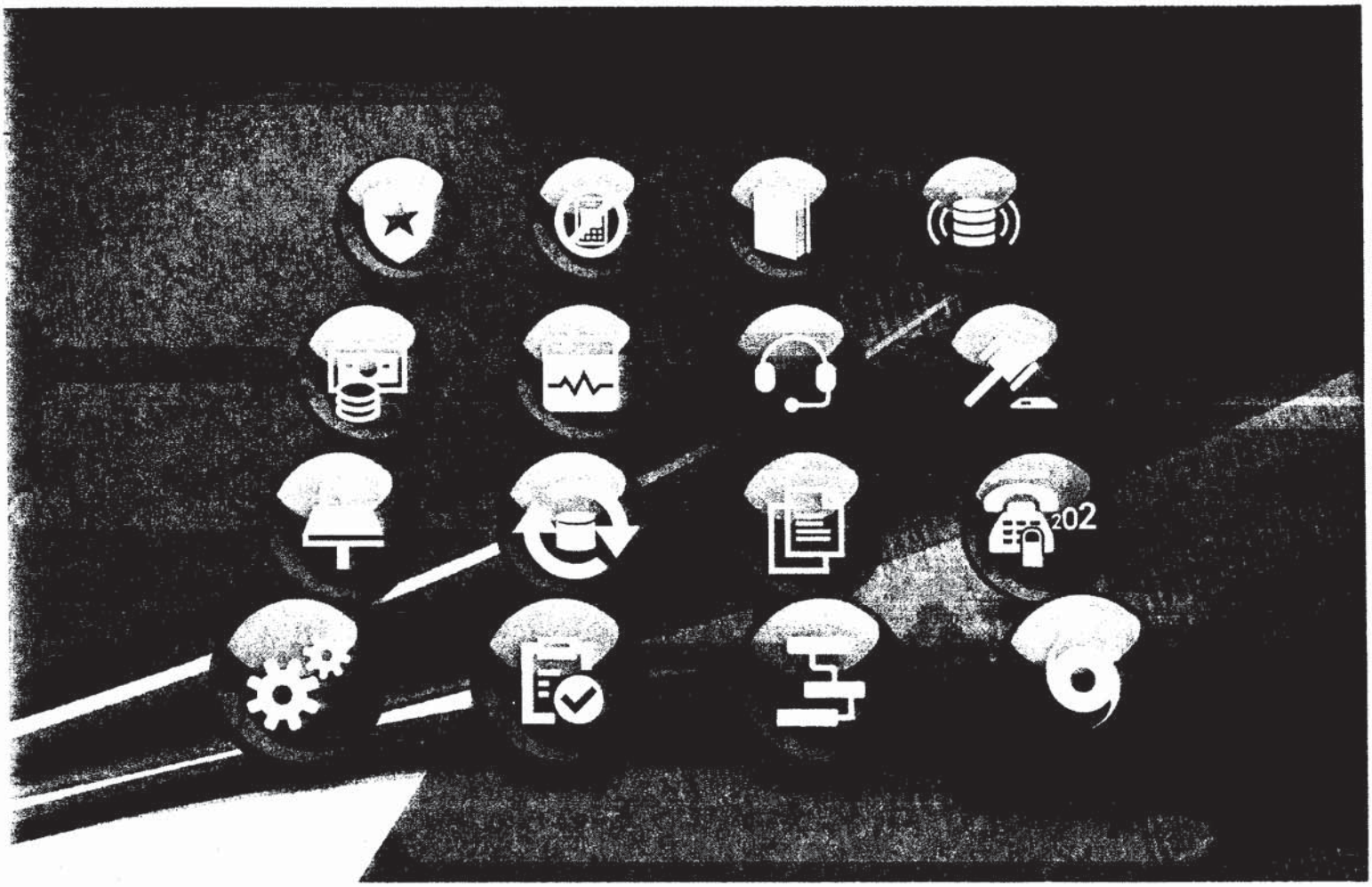
Optimal VoIP Call Routing Using NPAC



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Introduction

Mobile operators are migrating to the All IP networks. Companies such as Verizon Wireless and AT&T Wireless have national footprint and have VoIP gateways at different geographical locations (e.g., east coast and west coast). The mobiles can roam in the US to a location far away from their home system. It would be nice to be able to route incoming VoIP calls to the mobiles as close as possible to where the roaming mobiles are.

Problem Statement

When mobile operators have IP-interconnections with other operators, mobile or non-mobile, the routing of an incoming VoIP call to their telephone number (TN) would be to a specific IP gateway of the destination mobile operator that covers the geographical area of the destination TN.

When a mobile roams from an east coast system to a west coast system, an incoming VoIP call from mid-west or west coast area to such a roamer would be terminated to the IP gateway in the east coast and then routed to a west coast system. So the call routing in the IP domain is not optimal for destination mobiles that are roaming.

Previous Options

When handling a VoIP call, the originating or transit network may be configured to route the call to one of the destination mobile operator's IP gateways based on the destination TN's geographical area or use the VOICE Uniform Resource Identifier (URI) information that is provisioned in the NPAC for the destination TN by the mobile operator who serves that TN.

The VOICE URI information that is provisioned by a mobile operator in the NPAC for a served TN would normally be associated with that TN's geographical area (e.g., an east coast IP gateway is associated with an east coast TN) and stays static. The same may apply to the IP gateway info given to the IP-interconnection partners.

So the previous options may result in non-optimal routing in the IP domain for roaming mobiles as shown in Figure 1.

Please note that there may not be a transit operator between the originating operator and destination operator when they have peering points for direct interconnections.

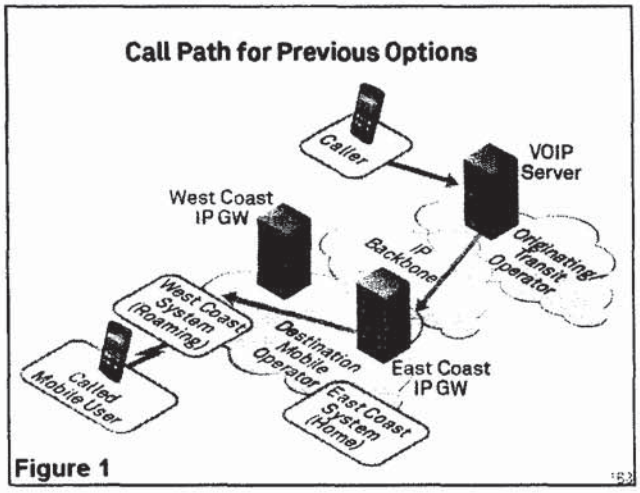


Figure 1

Praxis Solution

The proposed solution is to have the VOICE URI information for a mobile TN in the NPAC dynamically updated based on the mobile's roaming location. So when a mobile from the east coast system is roaming in a west coast system, the VOICE URI information provisioned in the NPAC would be changed from the east coast IP gateway to the west coast IP gateway. If a mobile operator provisions all the IP gateways in the NPAC with different preference values for alternate routing in case of IP gateway failure(s), the preference of the east coast IP gateway would be changed from the highest preference value to a lower value and the west coast IP gateway would be changed from a lower value to the highest value.

There are two options for a mobile operator to update the VOICE URI information in the NPAC.

1. The roamer's home mobile operator uses the existing NPAC Service Order Administration (SOA) interface or the Graphic User Interface (GUI) to update the VOICE URI information for the affected TN (e.g., change the VOICE URI strings or the preference values of the VOICE URI strings). This requires that the Home Location Register (HLR)/Home Subscriber Subsystem (HSS) or the IP Multimedia Subsystem (IMS) Call Session Control Functions (CSCFs) in the mobile operator networks notify its provisioning system when it detects the location change that requires updating the VOICE URI information in the NPAC.

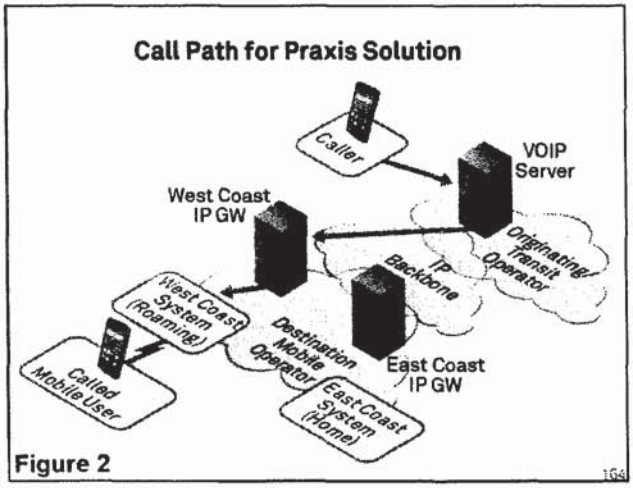
2. The roamer's home mobile operator uses either an existing interface or a proprietary API to inform Neustar about the location of the mobiles. This avoids the effort for the mobile operators to enhance their systems to trigger their provisioning systems to use the NPAC SOA or GUI interface to update the NAPC.

   There are interfaces such as those used between the HSS and the Application Server (AS), between the CSCFs and the AS or between the HSS and the Gateway Mobile Location Center (GMLC) that can be used by Neustar to receive the mobile location information.

   The Neustar server that supports such interface(s) to some of the mobile operators would need to obtain beforehand the area covered by each of the IP gateway from each of the mobile operators using such interfaces. When the Neustar server receive the location information from a mobile operator for a TN, it can determine the appropriate IP gateway for that location and use the NPAC GUI interface to update the VOICE URI information for the affected TN in the NPAC when needed.

After the VOICE URI information is updated in the NPAC, the NPAC broadcasts the update via the Local Service Management System (LSMS) interface as is done today. The network operators and VoIP service providers then use the updated VOICE URI information for routing to the affected TN.

Figure 2 shows that the routing of an incoming VoIP call to a roaming mobile is optimized with this solution when an east coast mobile roams to a west coast system.



The saving is obvious for the destination mobile operator. The IP packets for the incoming VoIP call is now transported between the west coast IP gateway, which is much closer to the roaming mobile, and the west coast system.

For the originating/transit operator, the saving is realized when its IP gateway that handles the outbound VoIP call is located in the west coast. However, there is no saving for the originating/transit operator if its IP gateway is located in the east coast. In this case, the IP gateway can choose not to use the VOICE URI information from the NPAC if it is provisioned with the destination operator's east coast IP gateway information and sees that the IP gateway from the NPAC is not a good choice from its perspective.

The interconnection-agreements between the originating or transit operator and the destination mobile operator would impact how the incoming VoIP calls to the destination mobile operator are handled and routed by the originating or transit operator.

Benefits

- The destination mobile operator is benefited when the IP gateway that is close to the roaming mobile is the one to receive the incoming call. A roaming mobile would normally stay in the roaming mobile system for a while so the frequency of updating the VOICE URI information in the NPAC is not often.
- The originating or transit operator is benefited when its IP gateway that handles the outbound VoIP call is close to the IP gateway specified by the VOICE URI information received from the NPAC.
- The mobile operators can use the existing NPAC SOA or GUI interface to update the VOICE URI information in the NPAC for the affected TNs. The operators, mobile or non-mobile, and the service providers can receive the dynamically updated VOICE URI information over the existing LSMS interface.
- It avoids enhancement to the mobile operators' system to support this solution if they treat Neustar server as an AS to receive the mobiles' location information. Neustar may be able to charge for the service.
- The delays in media exchanged between the calling and called devices are slightly reduced because the IP packets travel less distance between the devices and possibly less routers. The reduction may look small in msec. (e.g., 10 msec.) but is actually not small when comparing with the actual time that an IP packet is transported from one device to another. The voice quality could be slightly improved.

Implementation

The mobile operators can use the existing NPAC SOA or GUI interface to update the VOICE URI information for their affected TNs. The mobile operators would need to enhance their systems to support this solution. There is no impact on the NPAC except for more requests over the SOA or GUI interface and more broadcasts over the LSMS interface.

If the mobile operators uses the interface to an AS or a proprietary interface specified by either a mobile operator or Neustar to inform Neustar about the mobiles' location information, Neustar would need to deploy a server to receive the mobiles' location information and also obtain the serving area

for each of the IP gateway from the requesting mobile operators beforehand so as to be able to determine the IP gateway based on a mobile's location and update the VOICE URI information in the NPAC via the NPAC GUI interface for the affected TN when needed.

Figure 3 shows the high-level interactions among the involved systems/entities when a non-SOA/ non-GUI interface is used.

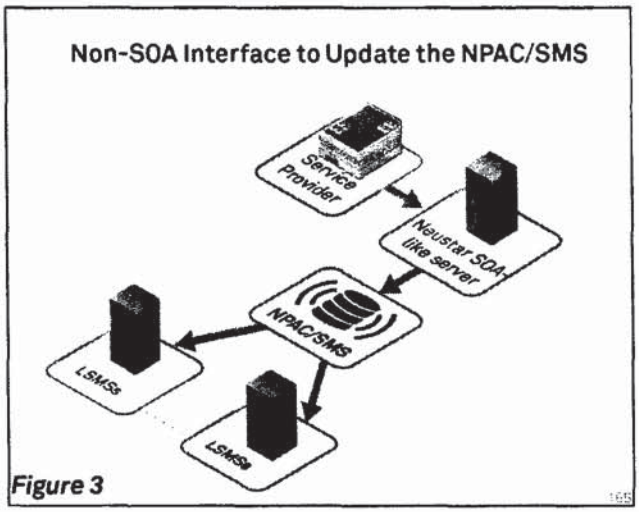


Figure 3

Conclusion

This white paper describes a solution that makes use of the NPAC to update the VOICE URI information for an affected TN when its associated mobile roams to a mobile system that can be accessed via an IP gateway that is closer to the mobile system where the mobile is roaming.

The mobile operators can use the existing SOA or GUI interface to update the VOICE URI information in the NPAC as is done today. Some can use a non-SOA or non-GUI interface to inform Neustar about the mobiles' location information so that Neustar updates the VOICE URI information in the NPAC on behalf of the mobile operators when needed.

The VoIP call path, when optimized, would benefit the destination mobile operator and it may benefit the originating/transit operator in certain routing scenarios. The media exchanged between the calling and called devices could travel a shorter distance that could result in a better voice quality.

Abbreviations Used in This Document

Acronym	Definition
AS	Application Server
CSCF	Call Session Control Functions
HLR	Home Location Register
HSS	Home Subscriber Subsystem
LSMS	Local Service Management System
GMLC	Gateway Mobile Location Center
GUI	Graphical User Interface
IMS	IP Multimedia Subsystem
IP	Internet Protocol
NPAC	Number Portability Administration Center
SOA	Service Order Administration
SIP	Session Initiation Protocol
TN	Telephone Number
URI	Universal Resource Identifier
VOIP	Voice Over Internet Protocol
SMS	Short Messaging Service
SPID	Service Provider ID
TN	Telephone Number
URI	Universal Resource Identifier
VoIP	Voice over Internet Protocol

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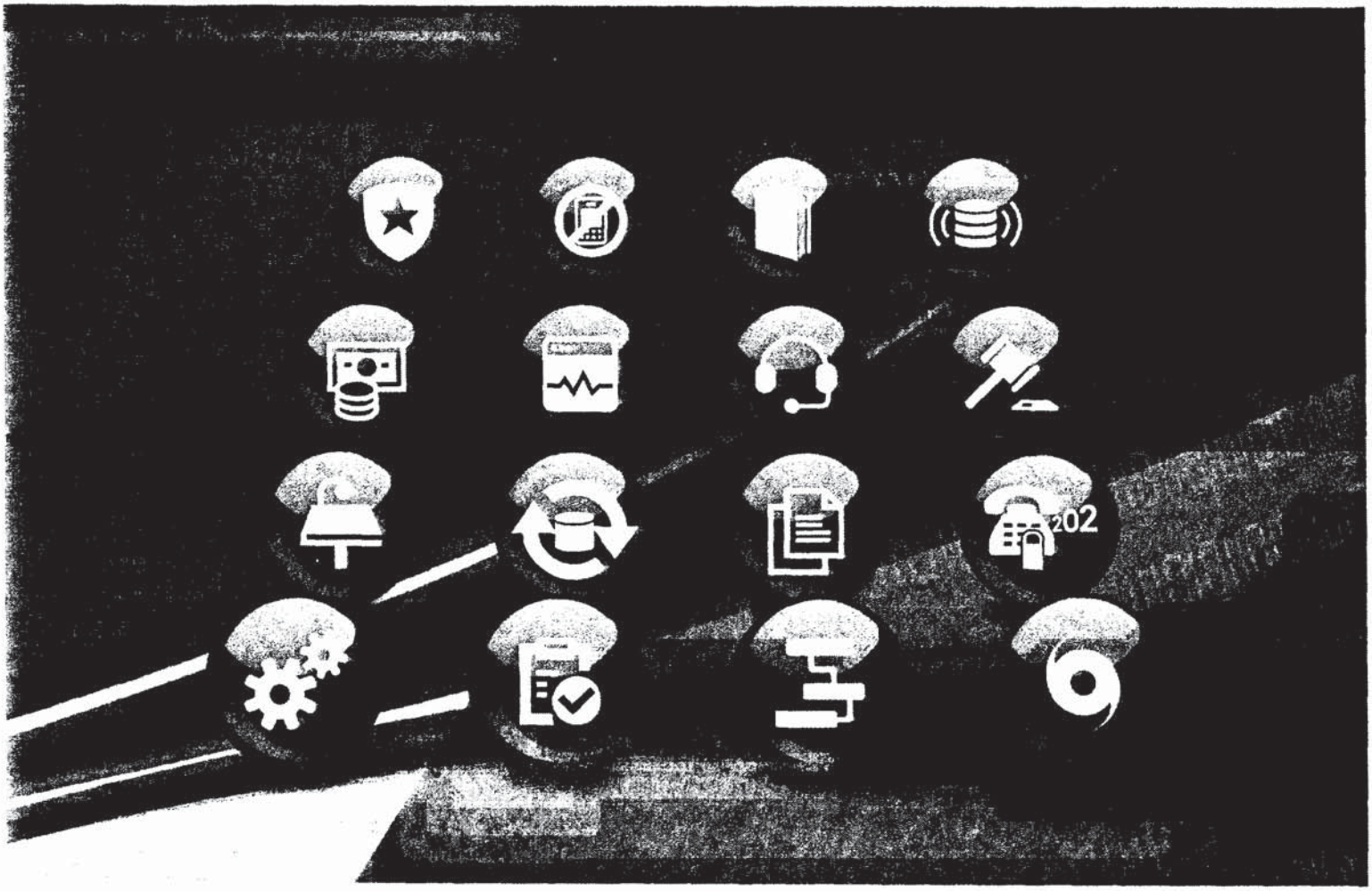
Data Format Recommendations for Voice/SMS/MMS URI Fields in the NPAC



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Introduction and Overview

This whitepaper proposes data format recommendations for three of the five recently added Uniform Resource Identifier (URI) fields in the NPAC across all U.S. and Canada regions. Currently, the NPAC database contains the following URI fields for 7-digit number pool blocks and 10-digit Telephone Numbers (TNs):

1. VOICEURI
2. SMSURI
3. MMSURI
4. PRESURI (currently, only available for use in Canadian region)
5. POCURI (currently, only available for use in Canadian region)

Each of these URI fields can contain an ASCII string of up to 255 characters, excluding the pipe character (|), or ASCII code 0x7C (See NPAC Functional Requirement RR3-3: NPAC Service Management System Input Restrictions). Data format recommendations for the VOICEURI (NANC 429), SMSURI (NANC 435) and MMSURI (NANC 430) are proposed in this whitepaper and look to leverage existing industry standards, where available and applicable. Where industry standards are not available, modest extensions to established ones are suggested. Industry feedback on these proposed recommendations is encouraged.

Use of the NPAC for IP Service Communities

The NPAC URI fields can be used for:

1. Broadcasting text messaging capabilities on wireline numbers (whitelisting). If special commercial arrangements are not made for this today, SMS and/or MMS delivery to non-wireless telephone numbers will fail.
2. Broadcasting IP-based voice termination points, similar to Destination Point Codes (DPCs), of where to discover specific IP-based voice termination routing information. This use case has been gaining momentum in light of recent regulatory positions and proposed rule makings.

Using an established, authoritative, and neutrally administered registry for these use cases can help save costs relative to existing ad hoc and manual approaches, as well as improve data quality and integrity since now the relevant information is consolidated into one, industry-recognized, authoritative database. (Note: in 2010, as a means of mitigating the capacity constraints of traditional LSMSs, the NPAC was modified per NANC change order 442 to allow for telephone numbers to be provisioned with all 0's in the LRN field. These NPAC records, known as "Pseudo-LRN" records, are designed to store a broader set of telephone numbers and associated attributes, such as NPAC URIs.)

High-level Solution

Although the population of NPAC URI fields is increasing, it is generally held that a set of industry guidelines are required so that all participants in the various ecosystems can efficiently automate direct use of these optional fields in a common way. NPAC URI field values populated today are fully qualified domain names or host names and do not comply with standard URI syntax, as specified in IETF RFC 3896.

Since URI fields are generally intended for IP-related services, DNS ENUM specific URI schemes should be followed, as specified in IETF RFC 6118. If the NPAC URI fields are not used, additional routing mechanisms will be required. The proposed use of these NPAC URI fields is consistent with the concept of DPCs, as well as with more commonly referenced carrier ENUM (tiered) architectures.

Neustar's Data Format Recommendations

The following sections contain three important recommendations:

1. Recommendations for the SMSURI, MMSURI and VOICEURI data fields
2. Recommendations for supporting multiple URI values within a single field
3. Recommendations for Tier-2 delegations as further defined below

SMSURI Format

RFC 6118 contains the following two scheme definitions, as specified by IETF RFC 4355:

- sms:mailto
- sms:tel

The recommended value for the SMSURI field in NPAC is one of the following URI schemes:

- mailto:
- tel:

The mailto: URI syntax is specified by IETF RFC 6068. The following is an example:

mailto:\1@sms.example.com?spid=X109

which would be mapped into a NAPTR record, such as:

IN NAPTR 10 10 "u" "E2U+sms:mailto" "!^(.*)$!mailto:\1@sms.example.com?spid=X109!" .

The tel: URI syntax is specified by IETF RFC 5341. New parameters, such as "spid", are needed to carry additional data fields, such as:

tel:\1;rn=7035551234;npdi;spid=X109

which would be mapped into a NAPTR record, such as:

IN NAPTR 10 10 "u" "E2U+sms:tel" "!^(.*)$!tel:\1;rn=7035551234;npdi;spid=X109!"

Note: IETF RFC 4694 defines Number Portability (NP) related parameters, while IETF RFC 4904 specifies parameters related to trunk groups. The "spid" parameter is recommended to be defined by NPAC Functional Requirement RR4-6: New Service Provider ID and CMIP ASN.1 Data Type Definition:

GraphicFixedString4 ::= GraphicStringBase(SIZE(4))

ServiceProvId ::= GraphicFixedString4 -- (must be 4 alphanumeric characters).

New tel: URI parameters, such as "spid", would be registered with IANA at:

http://www.iana.org/assignments/tel-uri-parameters/tel-uri-parameters.txt

and would follow IETF recommendations for avoiding any possible conflicts.

Data Format for URI Fields

MMSURI Format

RFC 6118 contains the following two scheme definitions, as specified by RFC 4355:

- mms:mailto
- mms:tel

MMSURI values are recommended to follow the same formats of the SMSURI values, except that the URI scheme is mms, instead of sms.

VOICEURI Format

RFC 6118 contains the following five scheme definitions for voice-related DNS ENUM services:

- pstn:tel IETF RFC 4769
- pstn:sip IETF RFC 4769
- h323 IETF RFC 3508
- sip or sips IETF RFC 3764
- voice:tel IETF RFC 4415

Because RFC 3764 is an older version of the more generic SIP related protocols, RFC 4415 is more related to peer-to-peer interactive voice sessions, and "h323" would be required for supporting some existing regulated services (e.g., Telecommunications Relay Service), the proposed recommendation is to support the following three URI schemes:

- pstn:tel
- pstn:sip
- h323

with the corresponding DNS ENUM service names, such as:

- e2u+pstn:tel
- e2u+pstn:sip
- e2u+h323

The following are example URI values for each of the above schemes:

- tel:\1;rn=7035551234;npdi;spid=X109
- sip:\1;rn=7035551234;npdi@example.com;user=phone
- h323:\1@example.com

These would in turn be mapped into NAPTR records, such as:

- IN NAPTR 10 10 "u" "E2U+pstn:tel" "!^(.*)$!tel:\1;rn=7035551234;npdi;spid=X109!"
- IN NAPTR 10 10 "u" "E2U+pstn:sip" "!^(.*)$!:\1;rn=7035551234;npdi@example.com;user=phone!" .
- IN NAPTR 10 10 "u" "E2U+h323" "!^(.*)$! h323:\1@example.com!" .

Again, any new tel: URI parameters, such as "spid", would be registered with IANA.

Multiple URI Values

It may be desirable to provision multiple URI values into a single NPAC URI field, e.g., to represent different URI values, redundant name servers, etc. To facilitate this, a URI value separator or delimiter is required. If the character used as the separator or delimiter occurs in a URI value, it should be encoded as %XX, where XX is the hex value of the character. This chosen character is proposed to be an ASN.1 GraphicString character other than "|" (0x7C), which is currently reserved by NPAC.

The order of multiple URI values in a single URI field may be used to derive the order or preference values of NAPTR records. For example, if "!" (hex 0x21) is chosen as the separator, a VOICEURI field with both sip and tel URI values can be specified as:

sip:\1;rn=7035551234;npdi@example.com;user=phone!tel:\1;rn=7035551234;npdi

which would be mapped into two NAPTR records, such as:

Data Format for URI Fields

IN NAPTR 10 10 "u" "E2U+pstn:sip" "!^(.*)$!:\1;rn=7035551234;npdi@example.com;user=phone!" .

IN NAPTR 10 20 "u" "E2U+pstn:tel" "!^(.*)$!tel:\1;rn=7035551234;npdi!" .

with the sip URI value as the preferred one.

Please note that the LNPA Working Group may need to decide what can be populated in the URI fields, such as:

- rn
- spid
- svtype
- altspid
- lastaltspid
- other?

with a mandatory set, such as "rn" and "spid", and an optional set, such as "svtype" or "altspid", etc. Neustar is open to making such recommendations via its representatives to the LNPA Working Group.

Tier-2 Delegation

A Tier-2 delegation in NPAC would be comparable to standard DNS delegation where an authoritative name server for an IP domain receives a request for a sub-domain's records and responds with records for the other name servers.

Two possible mechanisms could be used to facilitate Tier-2 delegations in the NPAC database:

1. Populating non-terminal NAPTR records.
2. Directly specifying name server records.

Non-terminal NAPTR Records

If the URI value populated is simply a fully qualified domain name, it would be treated as a non-terminal NAPTR record, defined by IETF RFC 2915 and IETF RFC 6116.

For example, if the VOICEURI field is:

carrier-a.example.com

The corresponding NAPTR record would be:

IN NAPTR 10 10 "" "e2u" "" carrier-a.example.com

For example, after receiving the non-terminal NAPTR record, an ENUM client would perform a

DNS name server lookup for zone:

carrier-a.example.com

and then send the lookup query to one of the name servers returned, after replacing the terminating domain name to "carrier-a.example.com" in the query string.

Name Server Records

If the URI value populated starts with a scheme, such as "ns:" (TBD), it would be treated as a name server record, defined by IETF RFC 1035.

For example, if the VOICEURI field is:

ns:ns1.example.com!ns:ns2.example.com

The corresponding name server records would be:

IN NS ns1.example.com

IN NS ns2.example.com

Name Server Records:

- Pros: Uses well documented name server mechanism without extra lookups
- Cons: A new schemes needs to be defined for specifying name servers

Benefits to Industry

This whitepaper has proposed data format recommendations for URI fields in the NPAC. Using an established, authoritative, and neutrally administered registry for IP Service Communities can help save costs relative to existing ad hoc and manual approaches, as well as improve data quality and integrity since now the relevant information is consolidated into one, industry-recognized database. The adoption of existing industry standards for this relevant information further encourages broad adoption and high levels of integration across NPAC service order administration and local service management systems, as well as the addressing and routing platforms used by Service Providers.

Reference Material

So that all readers may follow the presentation and recommendations made in this whitepaper, we provide two important sources of reference that went into the research and writing of the document:

- Descriptions of the Internet Engineering Task Force Request for Comment (IETF RFC) standards used in this document
- Definitions of abbreviations used in this document

IETF RFC Standards Used in This Document

The guidelines recommended in this whitepaper are primarily supported by the IETF RFC documents. The mission of the IETF is to make the Internet work better by producing high quality, relevant technical documents that influence the way people design, use, and manage the Internet. The IETF RFCs referenced in this whitepaper and their latest publication dates are as follows:

- IETF RFC 1035 - Domain names - implementation and specification – 11/1987
- IETF RFC 2915 - The Naming Authority Pointer (NAPTR) DNS Resource Record – 09/2000
- IETF RFC 3508 - H.323 Uniform Resource Locator (URL) Scheme Registration – 04/2003
- IETF RFC 3764 - ENUM service registration for Session Initiation Protocol (SIP) Addresses-of-Record – 04/2004
- IETF RFC 4415 - IANA Registration for ENUM service Voice – 02/2006
- IETF RFC 4694 - Number Portability Parameters for the "tel" URI – 10/2006
- IETF RFC 4769 - IANA Registration for an ENUM service Containing Public Switched Telephone Network (PSTN) Signaling Information – 11/2006
- IETF RFC 4904 - Representing Trunk Groups in tel/sip Uniform Resource Identifiers (URIs) – 06/2007
- IETF RFC 5341 - The Internet Assigned Number Authority (IANA) tel Uniform Resource Identifier (URI) Parameter Registry – 09/2008
- IETF RFC 6068 - The 'mailto' URI Scheme – 10/2010
- IETF RFC 6116 - The E.164 to Uniform Resource Identifiers (URI) Dynamic Delegation Discovery System (DDDS) Application (ENUM) – 03/2011

Abbreviations Used in This Document

Acronym	Definition
ALTSPID	Alternative Service Provider ID
DNS	Domain Name Server
DPC	Destination Point Code
ENUM	Electronic Numbering Mapping
HTTP	Hyper Text Transfer Protocol
IETF	Internet Engineering Task Force
IP	Internet Protocol
LNP	Local Number Portability
MMS	Multimedia Messaging Service
NANC	North American Numbering Council
NAPTR	Naming Authority Pointer
NP	Number Portability
NPAC	Number Portability Administration Center
RFC	Request for Comment
SIP	Session Initiation Protocol
SMS	Short Messaging Service
SPID	Service Provider ID
TN	Telephone Number
URI	Universal Resource Identifier
VoIP	Voice over Internet Protocol

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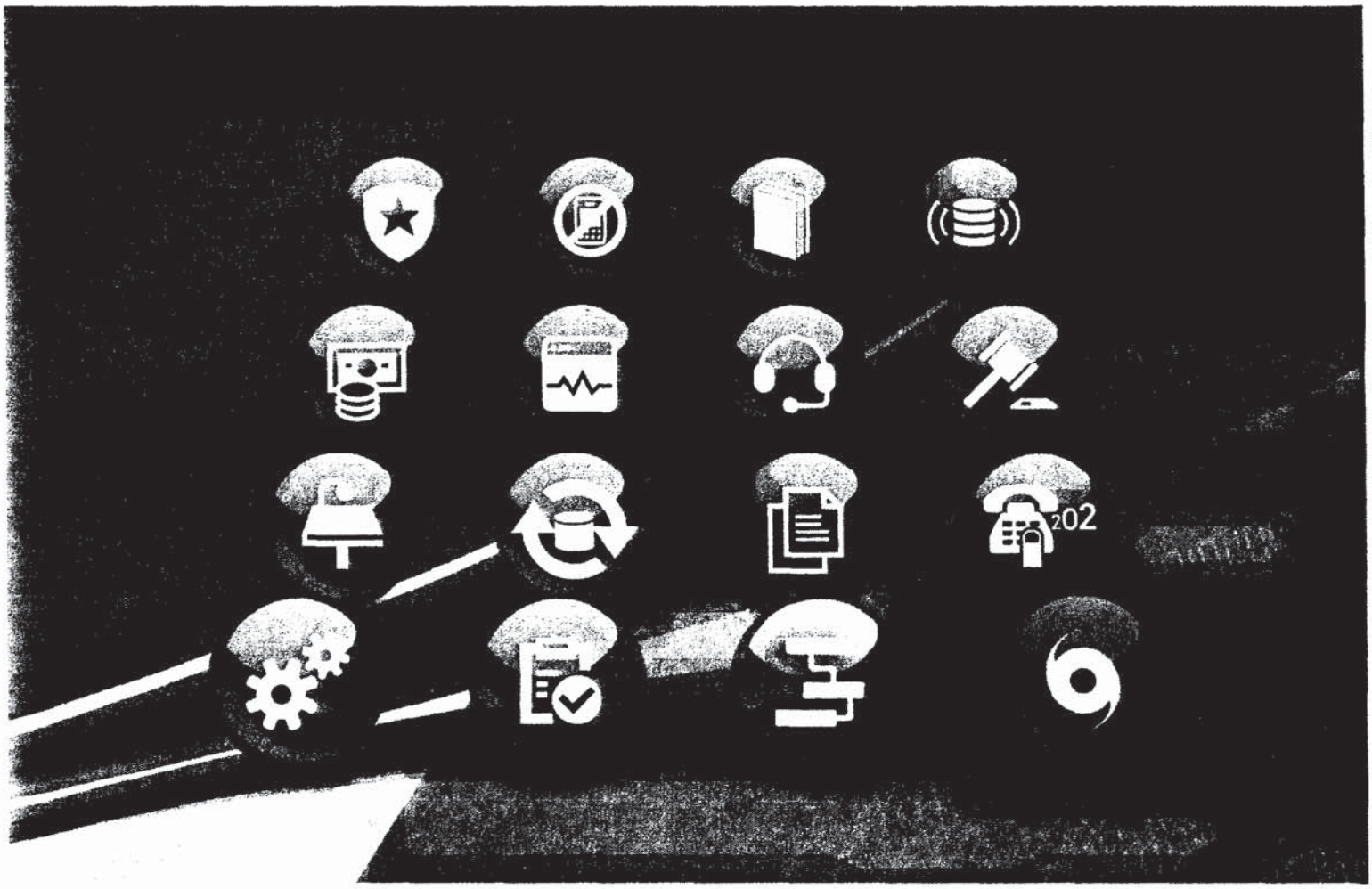
Telephony-Related Queries



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Introduction and Market Overview

Solution Highlights:

- ENUM adoption has been slow with its reliance upon DNS inhibiting maximum utility
- Growth in internet communication services and new entrants will drive additional use and needs from NPAC
- Telephone Related Queries, TeRQ, presents successor to ENUM with robust capabilities that enables custom queries
- TeRQ allows industry to grow into adjacent segments, services, and requirements that can be served by TNs

As telephone services increasingly migrate from the PSTN to the Internet, Internet applications require access to diverse information about telephone numbers. Voice-over-IP (VoIP) clients need to learn how to route calls based on telephone numbers. Web services want to deliver text messages to Internet-enabled smart phones.

Nearly fourteen years ago, ENUM was first issued as a standard for providing translations between telephone numbers and Uniform Resource Indicators (URIs) on the Internet. ENUM relied on the underlying infrastructure of the Domain Name System (DNS) for its query-response syntax and semantics. ENUM has frequently been positioned as a replacement for legacy PSTN database query protocols like TCAP. The intrinsic limitations of the DNS, however, have often been strained by the requirements for accessing information about telephone numbers. The DNS makes few provisions for authenticating the source of queries, however, so handling non-public information is constantly a challenge in ENUM deployments. The centralized and authoritative hierarchy of the DNS also proved a poor match for the actual procedures used to route telephone calls. For that reason, ENUM adoption has been slow outside of private deployments, and public ENUM federations, such as CC1 ENUM and the CableLabs Peer Connect registry, have had no practical impact for American consumers.

Over the last decade, however, the need for Internet applications to operate on telephone numbers has only grown more pressing. Today, many carriers across the globe have begun developing plans to migrate their entire PSTN infrastructure onto the Internet within the next decade. Further pressures come from emerging Internet communications providers, who unburdened with any legacy PSTN equipment and expenses, can more nimbly compete with services related to telephone numbers, and VoIP. As time goes on, more and more providers will want to access the NPAC via the Internet, and the fields of the NPAC will undoubtedly change to reflect the changing requirements of deployments. The industry has a clear need for a next-generation standard for accessing information about telephone numbers over the Internet.

Neustar's Solution

Neustar therefore proposes a new protocol and interface for Telephony-Related Queries (TeRQ). As a successor to ENUM, TeRQ builds on existing Internet technology, but rather than focusing on the DNS layer, TeRQ runs at the application layer. This allows for richer queries and responses, increased security properties, and greater efficiency. As TeRQ does not couple its service to the hierarchical namespace servers of the DNS, it also allows far greater flexibility in deployment architectures as well.

TeRQ is a query/response protocol that enables a Client to send Queries to a Service about telephone numbers or related telephone services. Queries may pass through one or more Intermediaries on their way from a Client to a Service; for example, through aggregators or service bureaus. A client establishes the Subject of a Query, and optionally specifies one or more Attributes of particular interest in order to narrow the desired response. When a Service receives a Query, it performs any necessary authorization and policy decisions based on the Source. If policy permits, the Service generates a Response, which will consist of a Response Code and one or more Records associated with the

Subject. The Service then sends the Response through the same path that the Query followed; transactional identifiers set by the Client and Service correlate the Query to the Response and assist any intermediary routing.

One of the unique strengths of this architecture is the distributed authority model it offers. Authorities provision Records into Services (via protocols such as DRINKS), and thus is it possible for Records to contain a signature from Authorities that can be verified by either Intermediaries or Clients. This allows for the preservation of end-to-end security when intermediaries are present, and even enables multiple Authorities to provision records associated with the same telephone number. As new services associated with telephony become available, this flexibility will be critical to maintaining competitive services that are compelling to end users. This authority-driven approach will also be critical to authorizing communications, and thus for functions like spam prevention and fraud management.

Since the world of applications that interact with telephone numbers is growing more diverse, TeRQ must be capable of operating in different application environments. For that reason, TeRQ is defined as a protocol that will be carried over an existing standard, such as HTTP for the web world or DIAMETER for emerging mobile telephone networks. This independence of underlying transport also makes TeRQ future-proof, as new encodings and bindings can be developed to support new standards as they emerge.

Today, Neustar is working towards standardizing TeRQ at the Internet Engineering Task Force (IETF). More information about the nature of the protocol and the status of work can be found on the IETF's web site. As we consider the longer term implications for the NPAC, two requirements can be considered:

- The NPAC should add an attribute to each SV and pooled block to designate the location of a Service Provider's TeRQ host server on its IP network. This field would behave in much the same way as the NPAC's existing SS7 DPC's, including CNAM – to inform other Service Providers where on the network they should look to retrieve information about the TN using the TeRQ protocol.
- The NPAC should be enabled to interact with Service Providers using the TeRQ protocol. For example, as a long-term replacement to the Inter-Carrier Process (ICP), TeRQ queries to the NPAC can be used to perform subscriber validation prior to the porting process.

Benefits to the Industry

TeRQ makes it possible for the NPAC community to grow beyond the confines of the PSTN, and to incorporate the new services and requirements that telephone numbers will encompass. With TeRQ, it will be simpler for existing PSTN Service Providers to migrate their networks onto the Internet, as well as for new Internet-based providers to gain access to critical information necessary to use telephone numbers to their fullest. The inherent distributed architecture of TeRQ does not require the top-down hierarchical model that constrained ENUM, and thus is faces far fewer hurdles to deployment. Moreover, the solution has a much stronger security story than ENUM, which again makes TeRQ more likely to succeed in an open Internet environment.

Abbreviations Used in This Document

Acronym	Definition
CC1	Country Code 1
CNAM	Caller ID Name
DNS	Domain Name System
DPC	Data Point Code
ENUM	E.164 NUmber Mapping
HTTP	Hypertext Transfer Protocol
ICP	Inter-Carrier Process
IETF	Internet Engineering Task Force
IP	Internet Protocol
NPAC	Number Portability Administration Center
PSTN	Public Switched Telephone Network
SS7	Signaling System 7
SV	Subscription Version
TCAP	Transaction Capabilities Application Part
TeRQ	Telephony-related Queries
TN	Telephone Number
URI	Universal Resource Identifier
VOIP	Voice Over Internet Protocol

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Telephone Numbers as Secure Universal Identifiers

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Introduction and Market Overview

Telephone Numbers (TNs) have long been used as an identity by individuals and businesses, extending far beyond communications Service Providers. As everything moves to the Internet, TNs continue to be used as an identity, but their usefulness becomes limited as validation techniques grow more cumbersome. Associating digital certificates to TNs through the authoritative registry provided by the NPAC will greatly enhance the ability to leverage TNs as validation for subscriber identity.

Since TNs are globally unique, easy to store and transmit, and likely to persist with a particular individual (thanks to portability), many businesses will rely on them to uniquely identify a customer. Some even going so far as to use a telephone number as an account name. TNs serve well for this purpose because they are easily associated with names, addresses, and billing relationships with carriers. Given the many security concerns that confront the provisioning and delivery of Internet services, the reliability of TNs as stable customer identifiers offers a number of advantages over other Internet identifiers like email addresses. For example, it is now common practice for financial web sites to text a phone number to verify an individual who is attempting an unusual transaction, as this provides a secure "out of band" form of dual-factor authentication.

Solution Highlights:

- Growth of Internet based calls increase need to provide secure identities and reduce malignant abuses such as spoofing
- Assigning digital credentials to TNs presents a solution for secure and reliable identity management
- NPAC's certificate authority capability can be extended to support robust and secure authentication of TN over IP
- Evolution of Internet and networks creates opportunities to extend value of TN through digital certificates, specifically with:
  - Digital certificates as primary identifiers
  - Digital identity registers
  - Personal clouds

As telecom networks evolve toward Internet Protocol (IP) technology, a clear need arises to bind cryptographic credentials to TNs as reliable identifiers for individuals and to prevent unauthorized spoofing. Today, a blatant security gap exists as there is no secure way to validate the recipient of a call or message to a particular TN. Similarly, a potential problem also arises when identifying the source of telephone calls over the Internet. Caller ID is no longer a 100% reliable indicator; there are even telemarketing companies that launch calls from the Internet, claiming a fake Caller-ID, through gateways to the PSTN to spoof their originating telephone numbers. They do this to increase the chance that targets will answer the phone.

Assigning and administering digital credentials to subscribers can be a mechanism for Service Providers to drive additional value and build upon the affinity their customers have for their numbers. As the assignee of TNs to end users, communications Service Providers are in a unique position to take advantage of this widely used and understood form of identity. Extending the functionality of TNs in this manner can enable them to become the primary secure identity for cyberspace.

Neustar's Solution Concept

In order for TNs to serve as reliable identifiers on the Internet, they must be associated with a digital credential that can then be shared in IP communications, assuring that an entity on the Internet can legitimately claim authority for a number. Once the identifier is secured, it could be used for many applications that depend upon secure and reliable identity management, such as mobile finance and health care-related services.

Such a credential, once assigned, could be used to battle spoofing by providing a means to

authenticate the originator of phone calls and text messages over the IP network. RFC 4744, "Enhancements for Authenticated Identity Management in the Session Initiation Protocol," edited by Jon Peterson (a Neustar Fellow), defines a mechanism using digital certificates for securely identifying originators of SIP messages. This mechanism is designed to work with the sorts of digital certificates in use on the web today; that is, certificates that cover an Internet domain name. However, while extensive public key infrastructures already exist for the web, there is no similar certificate authority for telephone numbers. So, applying RFC 4474 to telephone numbers requires an authoritative root of trust for a new category of telephone number-based certificates.

For the North American Numbering Plan, the NPAC is a natural location for this certificate authority to reside. This capability will first and foremost allow for more secure TN routing and Caller-ID on the Internet (both for calls and text messages) – a natural extension of the NPAC's current role.

It happens that the need for such a credential has already arisen organically in NPAC operations. The NPAC has recently implemented a certificate authority (CA) for enabling secure access by Service Providers to perform porting and network management functions on their inventories (this replaces the previously-used Secure ID tokens distributed to carriers). With only minor modifications, this same authentication mechanism can be extended, first to assign to a certificate a specific scope of authority over one or more TNs, verifiable by other Service Providers with access to the NPAC. With additional new messaging interfaces that validate certificates and telephone number ownership, the NPAC as a part of its standard call-routing functions could then offer a security step for terminating Service Providers seeking authoritative validation Caller-ID.

To illustrate, a VoIP provider could place a SIP call from a particular TN and include in it (via RFC4474 Identity-Info header field value or a similar mechanism) a reference to a certificate with authority over the TN in the From header field value. Recipients of the call could use a variety of standard protocols, including the Online Certificate Status Protocol (OCSP), to verify the authority of the certificate over the calling TN via the NPAC. Such a solution will verify that the call came from the Service Provider that was assigned the TN.

Because the NPAC is a neutrally-administered authoritative registry, and the entities that provision it are the Service Providers of record for the assigned TNs, the data can be trusted: the NPAC is the natural place to anchor a public key infrastructure for TNs.

Adding certificate holder attributes can expand this baseline solution to serve further needs of the NPAC community. For example, carriers increasingly want the ability to delegate certain NPAC provisioning capabilities to external parties such as resellers. With the approval of the primary, network-facing Service Provider, a reseller could be issued digital certificates that allow them to provision changes to limited fields in the NPAC (e.g. the URIs) for a specific range of delegated TNs, assigned to them by the primary. When the reseller establishes a connection with the NPAC and presents its certificate, the NPAC verifies the capabilities of that user with the certificate. This can streamline operations and optimize inventory management across the two companies.

One can extend the use cases even further. Digital certificates could be issued even to end users, as a means to enable third party authentication. Today, many websites and online applications use a subscriber's TN to identify them. This can be done by sending a text message to the user and taking them through a validation step (e.g., click a personalized link or enter a PIN code). To greatly streamline the set up process, the user could submit a certificate along with other credentials with the website verifying the TN with the NPAC.

These are just a few examples of how linking a certificate to a TN through the NPAC could confer the intrinsic security of TN to identity online.

Beyond TNs and Number Portability

The implementation of local number portability serendipitously protected the value of the phone number. With portability and the ability to permanently retain one's telephone number came a resilient and enduring identifier, one that continues to be used in many spheres beyond making phone calls (for example, loyalty cards). If portability had not been required, it is reasonable to ask whether telephone numbers would still have such an affinity, or whether another personal identifier would have taken ascendancy. Or, would consumers have a more fragmented identifier landscape than today? In either case, the Service Provider business landscape would have been altered significantly.

The NPAC provides the foundation for the continued utility of the phone number as an identifier, which is critical given the ongoing demand for telephone numbers by the general public. However, as networks, devices and the Internet evolve, Service Providers should continue to explore whether the phone number is the only identifier that Service Providers might use for persons or things on their networks.

We suggested earlier in this paper that a TN could be associated with a digital certificate for IP communications thus providing further security for its use as an identifier. This extension of the NPAC continues to put primacy on the telephone number. As the industry considers the evolution of the NPAC through 2020, the following additional (not necessarily dependent) evolutions should be evaluated:

1. Adding additional identifiers in the NPAC, beyond just TNs. TNs and other identifiers would be associated with the digital certificate.
2. Extension of the NPAC to a digital identity registry for use by consumers, offered by their Service Providers.
3. Allowing subscribers to link the digital identities (administered by their Service Providers) to online meta-services such as Personal Clouds.

Digital Identities

As networks evolve, it may be desirable to enable routing, rating, and billing via additional identifiers beyond phone numbers. Or, it may be desirable to link various identifiers together as a Digital Identity that is secured by a Digital Certificate.

In fact PKI and Certificate Authority (CA) technology are extremely mature, and the potential benefits of a centralized system are well understood, but no single vendor has ever been able to create a system with enough scale and ubiquity to be truly useful. The NPAC is arguably the only system in place today that could serve as the foundation for a successful and general purpose CA.

With a CA in place, linking and associating multiple device identifiers with single subscriber is straightforward. As we go beyond TNs to include additional identifiers, some examples of other device identifiers that could also be used on a network include:

- IP address
- MAC address
- FDA UDI
- Apple UDID

As devices become increasing abstracted or separated from the services people use (for example, virtual devices that run only in the cloud but remain users of the network), digital identifiers for the subscribers themselves can also be related to routing, rating and billing. Examples include:

- Email address
- OpenID
- XRI i-name or i-number
- Twitter handle

We could even get to the point where identifiers for content become necessary. For that, there are many interesting existing and emerging systems. Examples include:

- URIs
- Digital Object Identifiers
- UltraViolet

Enabling the NPAC to uniquely associate some of the above identifiers with subscribers would allow a highly flexible system for rating, routing and billing on the networks of the future.

Digital Identity Registry

The Internet is currently dominated by federated identity schemes that have achieved limited success because they could not establish both scale and durability to meet consumer expectations. As the NPAC expands to a universal TN registry, it will be in a position to maintain identifiers for almost every person in the US. It thus has the scale, authority, and durability required to dominate the digital identity landscape. Using the NPAC as the foundation for such a registry ensures that it would remain neutral, transparent, shared and under the auspices of the communications Industry.

Neustar has the technical know-how and experience to evolve the NPAC into an identity registry; based on digital certificates and/or identity registry technologies such as XDI, where Neustar has deep experience (Neustar operates the global XDI registry). XDI is both a discovery and registry service that enables persistent resolvable identifiers, as well as a semantic layer to enable well defined data interchange. This technology is foundational for Neustar's approach to personal clouds which is one of the applications of a digital identity registry

Personal Clouds

Consumers use multiple devices to access the same content and services. Cloud services such as Dropbox and iCloud and Google Apps further enable this general trend, moving storage and computing into the cloud. As consumers complete this shift and demand the ability, for example, to

access all of their personal data via the cloud or log in to all of their cloud services with a single or federated digital identity, the paradigm of "personal cloud" has started to emerge.

If we look beyond the narrow scenarios solved by each vendor mentioned above, a personal cloud ought to be a virtual wrapper around all of a consumer's cloud services and content – it's a meta-service. As such, digital identity is the cornerstone of a personal cloud, as that which links services and content together. But today there is no single identity service that is purpose-built for this use case (i.e., that would enable consumers to link their services and content together in meaningful ways), and thus the personal cloud space remains fragmented. What the web needs is a DNS scale service for real and permanent digital identity for personal clouds.

Neustar has been investing in this new type of identity service, using XDI (a global registry, discovery service, and data exchange protocol) to link data, devices and resources to a single identity, thus creating a "personal cloud." We're also developing an open source fabric that will enable an ecosystem of apps and services for the new digital identities. We are developing prototypes with partners, we are founding members of the Respect Network and we are working within the OIX approved Respect Trust Framework. Neustar brings special qualifications to the table: we are the registry for XDI (as well as multiple TLDs such as .biz, .co, .tel, and 358 new TLDs), we have a strong legacy of trust and respect for personally identifiable information, and we are capable of deploying and managing internet scale services.

Figure 1 below shows what Neustar is intending to build in partnership with the Industry:

- Fabric and network services that will enable essential functions such as discovery (finding other clouds)
- XDI based personal data store, which will enable a semantic and policy layer for data, thus enabling clouds to link to each other and exchange data.
- Cloud OS for evented apps related to data

Proposed Architecture for the Personal Cloud Fabric Open Source Project

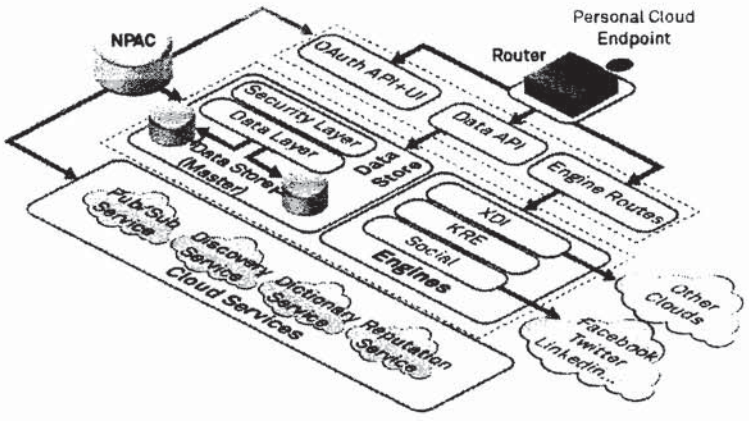

Figure 1

Just as the TN is the most important personal identifier in the world today, in part because of its portability that has created a sense of ownership and permanence in the minds of consumers, we believe the neutrality and scope of the NPAC is ideal for ensuring that the Service Providers, collectively, govern this emerging control point of the internet.

Abbreviations Used in This Document

Acronym	Definition
CA	Certificate Authority
DNS	Domain Name System
IP	Internet Protocol
MAC	Media Access Control
NPAC	Number Portability Administration Center
OCSP	Online Certificate Status Protocol
PIN	Personal Identification Number
PKI	Public Key Infrastructure
PSTN	Public Switched Telephone Network
TLD	Top-Level Domain
TN	Telephone Number
URI	Universal Resource Identifier
UDI	Universal Device Identifier
UDID	Unique Device Identifier
VOIP	Voice Over Internet Protocol
XDI	XRI Data Interchange
XRI	Extensible Resource Identifier

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